000046971

FINAL

VOLUME I - TEXT

SUMMARY AND ANALYSIS OF RESULTS

FIELD TREATABILITY STUDY

PHASE II

South Walnut Creek Basin
Surface Water Interim Measure/Interim Remedial Action

OPERABLE UNIT NO. 2

U. S. Department of Energy
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

January 1994

A-OU02-000897

TABLE OF CONTENTS

VOLUME II

LIST OF FIGURES

LIST OF TABLES

Section 5

Section 6

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in the Phase II Field Treatability Unit Study Report:

%R	Percent Recoveries
AA	Atomic Absorption
ARAR	Applicable or Relevant and Appropriate Requirement
CDH	Colorado Department of Health
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
DCN	Document Control Change Notice
DL	Detection Limit
DOE	Department of Energy
DQO	Data Quality Objective
EBCT	Empty Bed Contact Time
EPA	Environmental Protection Agency
IM/IRA	Interim Measures/Interim Remedial Action
IM/IRAP	Interim Measures/Interim Remedial Action Plan
FSP	Field Sampling Plan
FTU	Field Treatability Unit
GAC	Granular-Activated Carbon
GPM	Gallons (U.S.) per minute, also gpm
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HDPE	High Density Polyethylene
IAG	Inter-Agency Agreement
ICP	Inductively Coupled Plasma
i.d.	inside diameter
IDL	Instrument Detection Limit
kW	kilowatt
LCS	Laboratory Control Sample
MS	Matrix Spike
MSD	Matrix Spike Duplicate
O & M	Operations and Maintenance
OU2	Operable Unit No. 2
PA	Protected Area
PAC	Powdered-Activated Carbon
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCBs	polychlorinated biphenyls
PLC	Programmable Logic Controller
PPE	Personal Protection Equipment
psi	pounds per square inch
pCi/g	Picocuries per gram
pCi/ℓ	Picocuries per liter

QAA	Quality Assurance Addendum
QAPjP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFEDs	Rocky Flats Environmental Data System
RFP	Rocky Flats Plant
RI	Remedial Investigation
RPD	Relative Percent Difference
RRS	Radionuclides Removal System
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SVOC	Semivolatile organic compounds
TCLP	Toxicity Characteristic Leaching Procedure
TSD	Treatment, Storage or Disposal Facility
μg/kg	micrograms per kilogram
μg/ℓ	micrograms per liter
VOC	Volatile Organic Compounds
WSRIC	Waste Stream Residue Identification and Characterization

EXECUTIVE SUMMARY

This document presents the findings of the Phase II Field Treatability Unit (FTU) Study for the Operable Unit No. 2 (OU2) Surface Water Interim Measure/Interim Remedial Action (IM/IRA) at the Rocky Flats Plant. The scope of the OU2 FTU Program (including Phase I and Phase II) was submitted in the OU2 Surface Water Interim Measure/Interim Remedial Action Plan (IM/IRAP, DOE, 1991) which was subsequently approved for implementation by the U.S. Environmental Protection Agency (EPA) in March 1991 and the Colorado Department of Health (CDH) in May 1991. Phase I of the FTU study was initiated in May, 1991 and involved the use of bag filtration for suspended solids removal and granular activated carbon (GAC) for removal of volatile organic compounds (VOCs). Phase II of the FTU study commenced in April, 1992 with the objective of evaluating the effectiveness of expanded treatment for radionuclide and metals removal. The results of the Phase I study were presented in the Final Phase I Report, prepared in May 1992 (DOE, 1992). The results of the Phase II study are presented in this document.

The following objectives for the Phase II study were identified in the IRAP (DOE, 1991), the Project Work Plan, and project meetings between DOE and EG&G:

- Evaluate the potential of the treatment system to attain Applicable or Relevant and Appropriate Requirements (ARARs) for radionuclides, metals, and VOCs.
- Characterize influent surface water to facilitate recommendations for collection and treatment.
- Provide for the collection and treatment of flows exclusive of those resulting from high precipitation events.
- Characterize wastes and implement proper disposal in accordance with requirements.
- Initiate optimization of FTU operations to minimize chemical consumption and waste generation.

An evaluation of the effectiveness of the FTU operations revealed that the treatment system was generally effective in reducing influent VOC, radionuclide, and metal concentrations. Although influent concentrations were often below ARARs, comparison to effluent concentrations showed a small but measurable net reduction in concentration. Influent concentrations were generally too low to evaluate the system's effectiveness in treating higher contaminant levels; however, for those analytes that exceeded ARARs, the system was effective in reducing them to levels below ARAR.

The cost of surface water treatment (excluding residual waste management) during Phase II was approximately $402 per 1,000 gallons treated. Residual waste quantities have been significant and include not only sludge and spent GAC, but also air emissions from the diesel generator used to power the FTU, and solid and hazardous wastes generated during operation and maintenance of the system. The costs for treatment and disposal of sludge and GAC generated during this reporting period is estimated at $124,000 and $6,000, respectively. Additional costs will be realized for the storage, transportation and disposal of other solid and hazardous wastes.

As alluded to above, review of the relevant OU2 surface water quality data indicated that VOC and radionuclide levels were not as high as estimated in the IRAP. This prompted an assessment of the degree to which surface water quality met ARARs without treatment. This surface water characterization, or ARAR analysis, was performed to support an analysis of options for future surface water management.

The surface water characterization indicated that while one source (SW-59, a seep on the south bank of the South Walnut Creek drainage) contains analytes in concentrations that exceed ARARs, the surface water at two additional sources collected for treatment (SW-61 and SW-132) exhibit analyte concentrations below or near ARARs.

Considering the low frequency and magnitude of ARAR exceedances at SW-61 and SW-132, the high cost of treatment, and the additional costs for residual waste management, it is recommended that collection and treatment of surface water at SW-61 and SW-132 be discontinued. Because analyte concentrations occasionally exceed ARARs at these stations, particularly VOCs at SW-61, it is recommended that the current monitoring program be continued to observe trends in analyte concentrations at these sources. If the trend is toward more frequent and higher ARAR exceedances, the decision to discontinue collection of SW-61 and/or SW-132 will be reevaluated, with consideration given to additional source characterization. Results of the monitoring at these sources will be reported in the quarterly reports prepared for the field treatability unit.

Section 1

SECTION 1
INTRODUCTION

This document presents the findings of Phase II of the Field Treatability Unit (FTU) Study for the Operable Unit No. 2 (OU2) Surface Water Interim Measure/Interim Remedial Action (IM/IRA) at the Rocky Flats Plant. The scope of the OU2 FTU Program (including Phase I and Phase II) was submitted in the OU2 Surface Water Interim Measure/Interim Remedial Action Plan (IM/IRAP, DOE, 1991) which was subsequently approved for implementation by the U.S. Environmental Protection Agency (EPA) in March 1991 and the Colorado Department of Health (CDH) in May 1991. Phase I of the FTU study was initiated in May, 1991 and involved the use of bag filtration for suspended solids removal and granular activated carbon (GAC) for removal of volatile organic compounds (VOCs). Phase II of the FTU study commenced in April, 1992 with the objective of evaluating the effectiveness of expanded treatment for radionuclide and metals removal. The results of the Phase I study were presented in the Final Phase I Report, Summary and Analysis of Results prepared in May 1992 (DOE, 1992). The results of the Phase II study are presented in this document.

1.1 OU2 SURFACE WATER INTERIM MEASURE/INTERIM REMEDIAL ACTION

Rocky Flats Plant (RFP) (Figure 1-1) began operations in 1951. Waste management practices at the RFP have resulted in environmental contamination at several plant site areas. One such area, designated as OU2 (Figure 1-2) includes the 903 Pad, Mound, and East Trenches Areas. Past waste management practices at OU2 included solid and liquid waste disposal, reactive metals destruction, and waste burning.

The remedial investigation (RI) for OU2 began in March 1987. The investigation included soil, groundwater, and surface water sampling and analysis. The RI identified the presence of VOCs, radionuclides, and metals in OU2 soils, groundwater and surface water. While investigations

Figure 1-1

Location of the Rocky Flats Plant

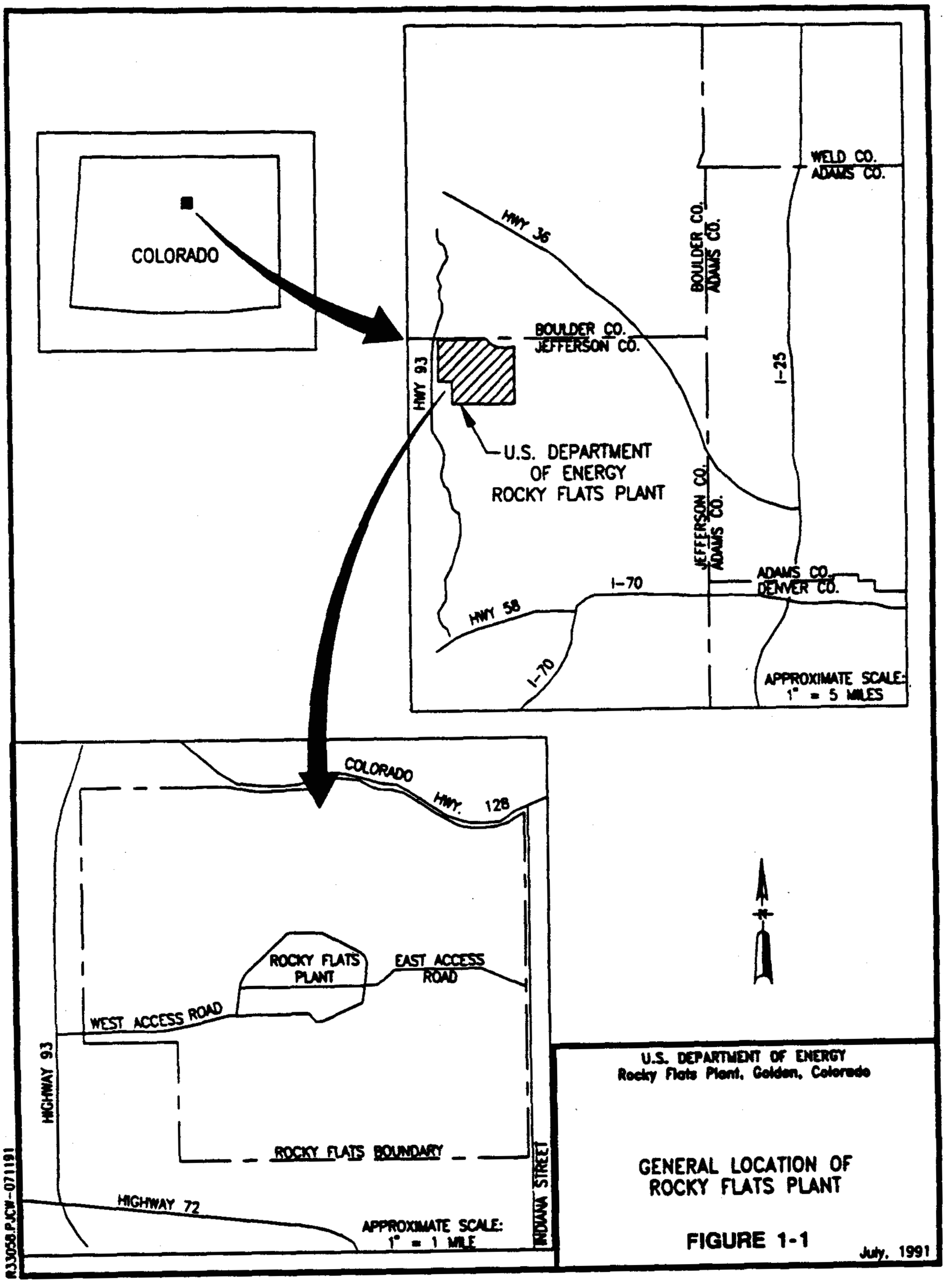
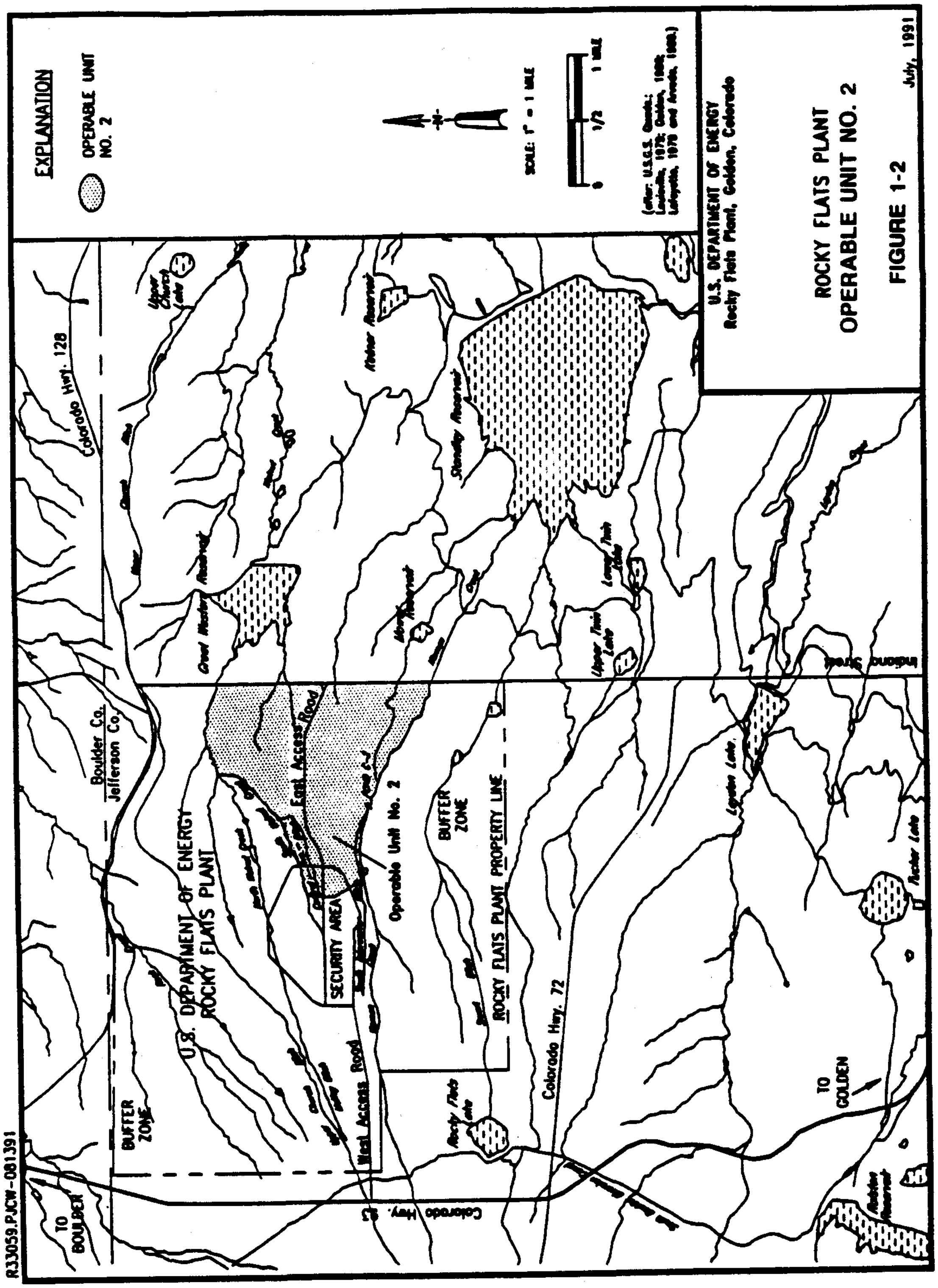


Figure 1-2

Rocky Flats Plant - Operable Unit No. 2



to fully characterize OU2 contamination continue and a final remedy is being determined, the Department of Energy (DOE) has pursued an OU2 surface water remediation under an IM/IRA.

A field treatability unit study was approved for implementation by the EPA in March 1991 and the CDH in May 1991. The IRAP (DOE, 1991) identified specific methods of collection and treatment of contaminated surface water in a portion of the South Walnut Creek drainage at OU2. Contaminants originate from contaminated surface water in the Protected Area (PA) and south of the PA. Initial characterization of these waters indicates the presence of radionuclides, heavy metals, VOCs, and suspended solids to which contamination may be adsorbed. The IRAP identified specific analytes of concern and established possible chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) as effluent standards for discharge of the treated water. Influent concentrations estimated from a flow-weighted maximum concentration model, were used to establish a basis for conceptual design for the surface water treatment system). These concentrations and their associated ARARs are presented in Table 1-1.

1.2 SITE LOCATION

As part of the IM/IRAP, surface water is collected from three locations within the drainage (Figure 1-3): SW-59, SW-61, and SW-132. SW-59 is a seep on the south bank of the South Walnut Creek drainage. SW-61 is located within South Walnut Creek and receives surface water runoff south of the PA (discharge from a corrugated metal culvert) and surface water runoff from within the PA (discharge from a concrete culvert). SW-132 is the discharge from a second corrugated metal culvert approximately 225 feet downstream of SW-61. The SW-132 discharge originates from South Walnut Creek west of Building 991 (a portion of South Walnut Creek that was filled during construction of Building 991).

Table 1-1

Basis for Design for FTU (Identified in the South Walnut Creek Basin IM/IRAP)

Analyte[1]	Unit	Influent Concentration[2]	ARAR
Radionuclides			
Am-241	pCi/ℓ	0.53	0.05
Gross α	pCi/ℓ	730.00	11.00
Gross β	pCi/ℓ	545.00	19.00
Pu-239/240	pCi/ℓ	3.28	0.05
U-total	pCi/ℓ	11.69	10.00
VOCs[3]			
1,1-Dichloroethene	μg/ℓ	142	7.00
Carbon Tetrachloride	μg/ℓ	219	5.00
Chloroform	μg/ℓ	82	1.00U
Tetrachloroethene	μg/ℓ	279	1.00U
Trichloroethene	μg/ℓ	153	5.00
Vinyl Chloride	μg/ℓ	—	2.00
Metals-Dissolved			
Iron	μg/ℓ	—	300.00
Manganese	μg/ℓ	0.5790	50.00
Metals-Total			
Aluminum	μg/ℓ	25.1214	200.00U
Arsenic	μg/ℓ	—	50.00
Barium	μg/ℓ	1.8530	1,000.00
Beryllium	μg/ℓ	0.0519	100.00
Cadmium	μg/ℓ	0.0132	5.00U
Chromium	μg/ℓ	0.1918	10.00
Copper	μg/ℓ	0.2664	25.00U
Iron	μg/ℓ	183.9643	1,000.00
Lead	μg/ℓ	0.1954	5.00U
Manganese	μg/ℓ	3.3068	1,000.00
Mercury	μg/ℓ	0.0022	0.20U
Nickel	μg/ℓ	0.2239	40.00U
Selenium	μg/ℓ	0.0070	10.00
Zinc	μg/ℓ	1.3475	50.00

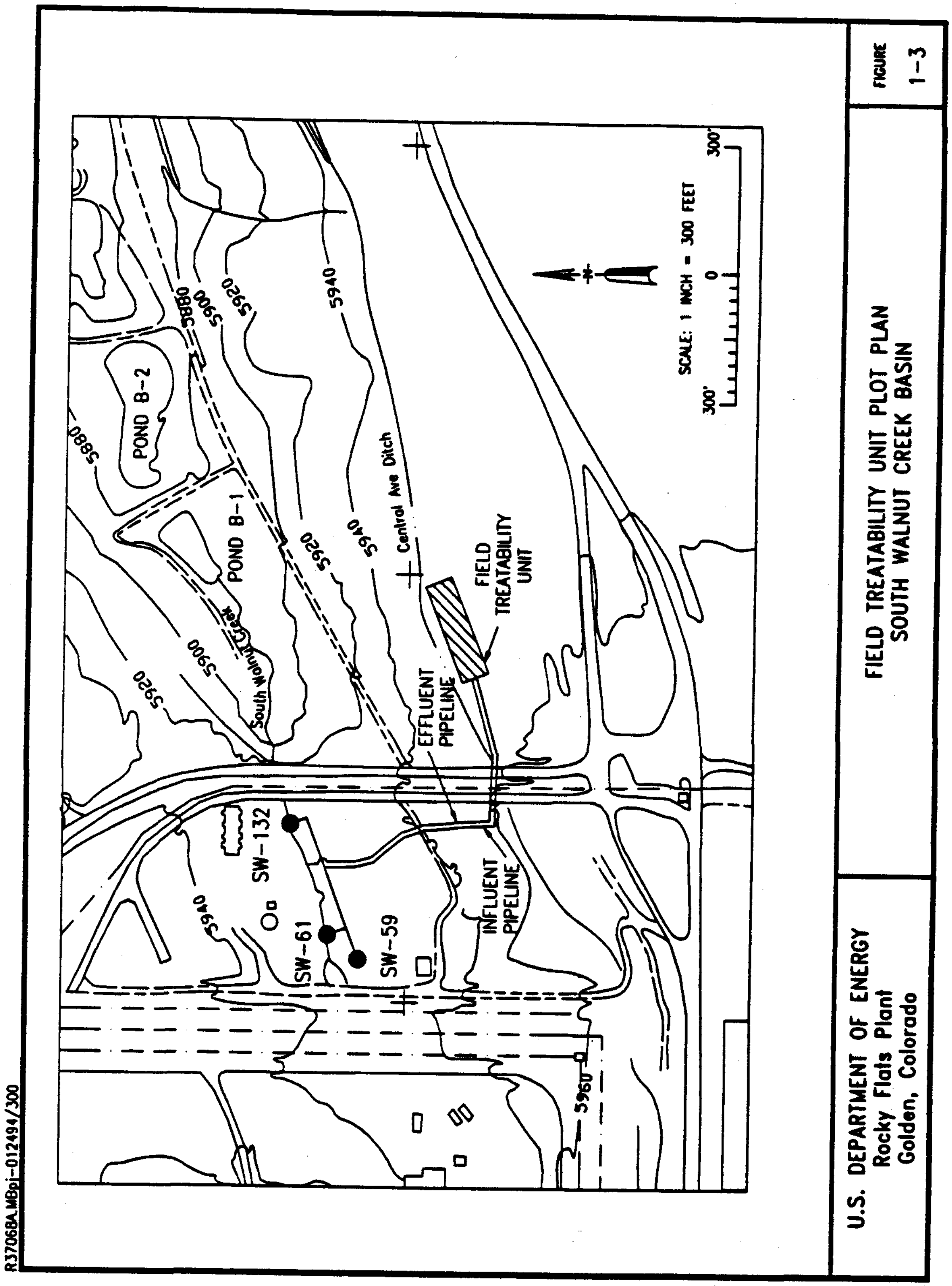
[1] From the IM/IRAP (DOE, 1991). Analytes presented in this table were detected in South Walnut Creek surface water and were identified in the IRAP as having an ARAR.

[2] Flow weighted average using maximum concentrations at SW-59, SW-61, and SW-132.

— Not calculated in the IM/IRAP.

Figure 1-3

**Field Treatability Unit Plot Plan
South Walnut Creek Basin**



1.3 TREATABILITY STUDY OBJECTIVES

The objectives for both phases of the treatability study are summarized from the IRAP (DOE, 1991), the Project Work Plan and project meetings between DOE and EG&G. The objectives include the following:

- Evaluate the potential of the treatment system to attain ARARs for radionuclides, metals, and VOCs.
- Characterize influent surface water to facilitate recommendations for collection and treatment.
- Provide for the collection and treatment of flows exclusive of those resulting from high precipitation events.
- Characterize wastes and implement proper disposal in accordance with requirements.
- Initiate optimization of FTU operations to minimize chemical consumption and waste generation.

1.4 IMPLEMENTATION OF THE TREATABILITY STUDY

The FTU Study was implemented in two phases. The Phase I treatment system, initiated on May 13, 1991, began with the operation of the surface water collection system, equalization tank, bag filtration for suspended solids removal, and GAC treatment of VOCs. During Phase I, surface water was collected from SW-59 and SW-61. Operation of the Phase I system continued until April 27, 1992, and was concluded with the Final Phase I Report, (DOE, 1992). The Phase I Report assessed performance of the system and its components, treatment system design, operational modifications, and waste stream characterization. The report also provided influent surface water characterization.

Phase II included incorporation of the Radionuclides Removal System (RRS), involving chemical precipitation and membrane filtration for radionuclide and metals removal as treatment upstream of the GAC units. The bag filters were removed from the system as they were no longer required. Phase II also included collection of surface water from SW-132. Operation of the Phase II collection and treatment system was initiated April 27, 1992 and presently continues through this date.

The Phase I Treatment System treated 7.3 million gallons of water at a design flow of 60 gallons per minute (gpm). Characterization of influent surface water for VOCs indicated that contamination of surface water was actually lower than that conservatively estimated in the IRAP. The most frequently occurring VOC, 1,2-dichloroethene (an analyte without an associated ARAR), was reported at concentrations averaging approximately 14 micrograms per liter ($\mu g/\ell$). Other VOCs were reported at levels exceeding the detection limit of 5 $\mu g/\ell$ each; these included tetrachloroethene, trichloroethene, and carbon tetrachloride.

The Phase I report concluded that the GAC system proved effective in removing VOCs to levels below ARARs. Design of the unit, using lead and polish columns, proved effective in preventing breakthrough and discharge of contamination. Improvement was needed in the use of upstream filters and back-washing techniques to minimize the carbon usage rate. During Phase I, GAC changeout was performed at approximately 120 day intervals. This time period was calculated based on contaminant concentrations.

Although the GAC system was not designed to treat radionuclides or metals, characterization of GAC influent and effluent for these contaminants was performed. The limited data analyzed from radionuclide and metals sampling showed effluent values that were generally below ARARs indicating the GAC system provided some removal for radionuclides and metals.

1.5 PHASE II REPORT OVERVIEW

Section 2 of this report describes the treatment system components and system operation and maintenance. Section 3 presents the methodologies employed to conduct the Phase II Treatability Study. Section 4 presents the results of the Phase II treatability study, focusing on the analytical results of the treatment processes evaluation. Section 5 focuses on the results of surface water sources characterization. Section 6 addresses data quality relative to both the treatability study (process evaluation) and surface water characterization. Section 7 presents conclusions for the treatability study and the surface water characterization, and provides recommendations for future OU2 surface water management.

Section 2

SECTION 2

TREATMENT SYSTEM DESCRIPTION

A process flow diagram showing the Phase II treatment system is presented in Figure 2-1. This equipment is housed in three trailers designated GAC, RRS I, and RRS II.

2.1 TREATMENT PROCESSES

2.1.1 Surface Water Collection, Transfer, and Equalization

The Treatment Unit is designed to divert and transfer surface water flows from SW-59, SW-61, and SW-132. The maximum design flow rate is 60 gpm. Flow in excess of the design capacity is permitted to overflow the collection system and continue downstream along the pre-IM/IRAP flow path.

Each collection system includes a precast reinforced concrete catch basin with a stainless steel submersible pump. Each pump is located inside a catch basin, and its operation is controlled by a float switch. Flow from SW-132 is pumped to the catch basin at SW-61. Flow from SW-59 is joined with the combined flow of SW-61 and SW-132 for transfer to the FTU. Raw water is pumped from the catch basins to a flow equalization tank. Flow rate monitoring at all collection points was in place by August 18, 1992.

Transfer piping consists of approximately 1,200 feet of 2-inch, inside diameter (i.d.) high-density polyethylene (HDPE) located concentrically inside containment piping. Containment piping is heat traced, insulated, and monitored for leakage. Return flow is provided by 3-inch piping, which is also heat traced and insulated, but not contained because the water is treated.

Collected flow is discharged into a 10,000-gallon equalization tank fabricated of cross-linked polyethylene which is provided with secondary containment and located adjacent to the treatment trailers. This tank provides hydraulic surge capacity and smooths variations in contaminant concentration. Surface water influent levels in the tank are continuously monitored and displayed. Level indication includes low, high, and overflow visual and audible alarms at 5, 90 and 95 percent of tank capacity. At peak flow (60 gpm) the tank can provide nearly 3 hours of equalization time. Equalization tank effluent flow rates are maintained by a valve at approximately 50 gpm. This is to provide a consistent flow rate through the treatment system.

2.1.2 Radionuclides Removal System

Water from the Equalization Tank is pumped into Reaction Tank No. 1 (TK-1), a continuously stirred, stainless steel tank. In this first 1,200-gallon tank, sulfuric acid is added to lower the pH to approximately 4.5. This step shifts the carbonate equilibrium from carbonate to bicarbonate, minimizing formation of uranium carbonate complexes which would resist chemical precipitation. Acidification also neutralizes total alkalinity. Ferric sulfate is then added as a coagulant and a coprecipitating agent.

Process water then overflows to Reaction Tank No. 2 (TK-2), a 1,200 gallon continuously stirred, stainless steel tank. Lime slurry is added to TK-2 to raise the pH above 9.5 (under normal operating conditions). This causes precipitation of metals as metal hydroxides. Radionuclides and metals adsorb to the particulates and are entrained in the flocs.

Under sustained high flow and/or high turbidity conditions, pH is elevated to approximately 10.5 by increased addition of lime slurry. The additional lime slurry increases the solids level which aids the next treatment step. The increased solids concentration increases the scouring action in the membrane circuit, and helps to maintain an effective filtration rate under these conditions. The amount of ferric sulfate (commercial Ferrifloc™) added to TK-1 also varies. This treatment occurs in RRS I which also houses the equipment for preparation, storage, and transfer of the chemical treatment agents to the reaction vessels.

The slurry of precipitated, co-precipitated and flocculated solids overflows from TK-2 into the solids concentration tank, TK-8. Residence time is not a controlled parameter in TK-2. TK-8 has a capacity of 3,000 gallons, is constructed of fiberglass-reinforced plastic, and is equipped with baffles, level controls, and a recirculation pump. Solids concentration in TK-8 is estimated twice daily by use of a pre-calibrated sample bottle. The sample bottle was calibrated by analytical laboratory determination of solids in previous samples. The analytical values of solids are used as a standard to compare observed sedimentation levels with actual solids values. Slurry that accumulates in TK-8 is circulated through the filtration system. The concentration and microfiltration systems physically separate the flocs formed in TK-2.

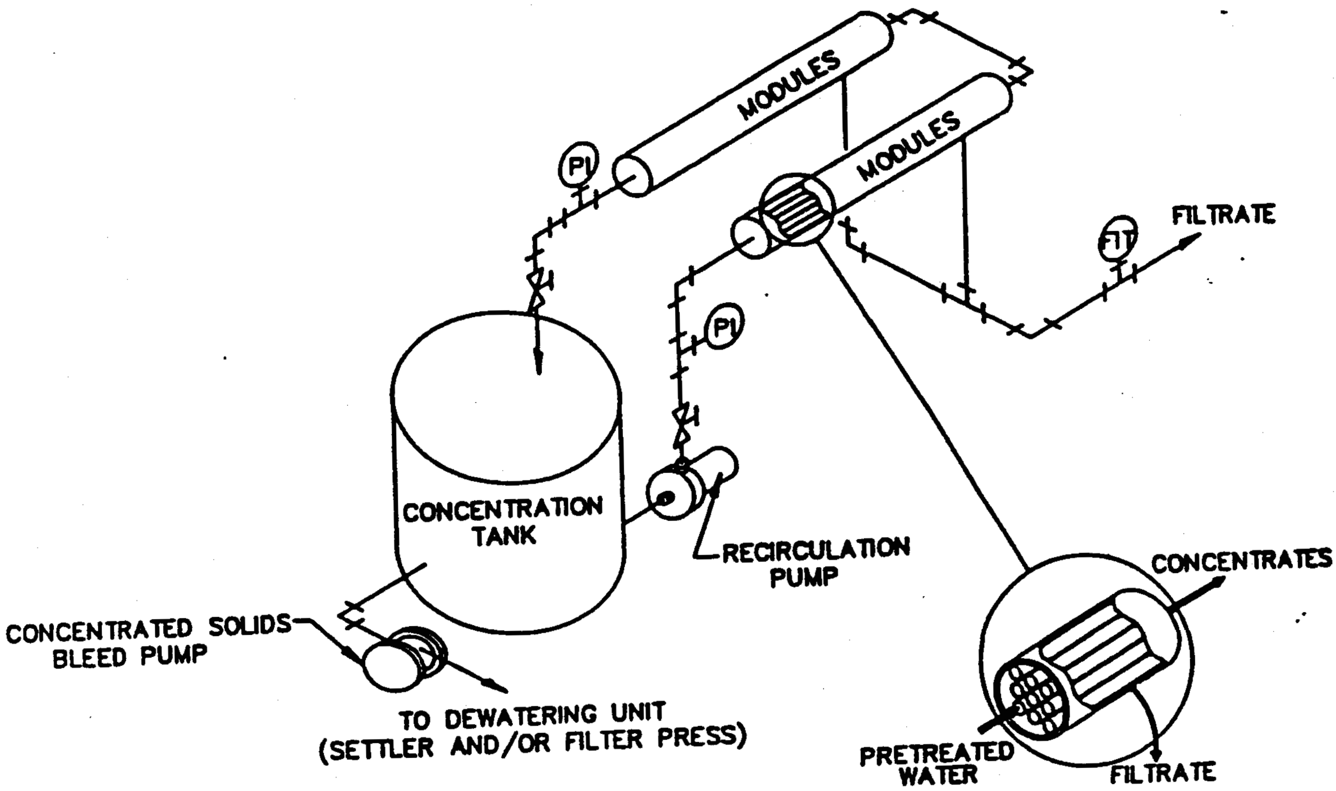
The filtration system is a shell and tube configuration consisting of 27 modules configured into three parallel paths with the membrane on the inside of the tubes. Figure 2-2 presents a diagram of the filter arrangement and detail of the filter. The permeate passes through the tubes perpendicular to the main flow at a relatively low operating pressure. The design is cross-flow so that high velocity flows clean the filter by scouring action. The filtration membrane is polymeric and rated at 0.10 micron (nominal) pore size by the manufacturer.

The permeate flows radially through the tubular membrane into a concentric annular space. Manifolds are provided to collect the filtrate and direct it by gravity flow to a neutralization tank. In the neutralization tank, TK-11, the permeate is neutralized to pH 7.0 by adding sulfuric acid. The neutralized liquid then flows to the GAC treatment units in the GAC trailer.

Filtered solids, which remain inside the filter membrane tube, are returned to the concentration tank. To maintain an effective filtration rate, solids concentration in TK-8 is controlled at a level of approximately 5 to 10 percent. Solids concentration is controlled by maintaining the liquid level in the concentration tank, sludge drawdown (sludge wasting), lime addition in TK-2, and the addition of powdered-activated carbon (PAC) to TK-8, when an increase in solids is needed to bring the level to the desired range.

Figure 2-2

Field Treatability Unit
Filtration Unit Basic Components



When solids in TK-8 have accumulated to the desired range, the sludge is drawn off for sludge storage and dewatering, which is performed in RRS I. Sludge is drawn off the bottom of the concentration tank and transferred to a conical bottom holding tank, TK-12. Settling is allowed to take place for approximately 12 hours. During periods of sludge accumulation, supernatant liquid is returned to the concentration tank by overflow. When sufficient solids have accumulated, they are pumped via an air operated slurry pump to the adjacent plate and frame filter press, where dewatering occurs.

The filter cake produced by the plate and frame filter press contains approximately 50 percent solids. The filter press accepts the pumped slurry until the 100 pounds per square inch (psi) pump discharge pressure is counterbalanced by filter cake resistance. At this point, filtrate flow back to TK-8 can no longer take place and flow terminates. The filter is allowed to drain and residual pressure returns drainage to TK-8. The press is opened and sludge drops into the storage drums beneath.

2.1.3 GAC Treatment

Neutralized process water is pumped from TK-11 in RRS II to the GAC treatment units. The GAC treatment units are housed in a separate GAC trailer. The GAC trailer contains four Cyclesorb™ units that are plumbed together using stainless steel quick connect couplings. Two units are on line, and two units are on standby. Standby units are prepared for use by soaking with treated water and are kept in the ready and warm condition. During Phase I, the bag filters were housed in the GAC trailer. These bag filters have been replaced by the RRS and have been eliminated from the treatment process.

Characterization data from the RI were used by the process supplier (Calgon Corporation) to recommend a suitable carbon. A proprietary A-300 carbon derived from coconut was selected for this application. Alternative carbons were not evaluated in this program. The GAC units used in Phase I were changed to fresh units in Phase II.

The GAC system consists of two Cyclesorb™ units arranged in series. Each unit is a stainless steel column measuring 60 inches in diameter, 87 inches in height, and contains 2,000 pounds of A-300 carbon. The units are sequenced in a lead/polish mode based on a timed interval that is determined by flow and concentration of organics. Empty bed contact time (EBCT) was specified by the IM/IRAP as approximately 18 minutes using a conventional downflow, sequential, lead/polish GAC treatment sequence. The design flow rate of 60 gpm provides a residence time of approximately 20 minutes. Effluent flow rates are monitored and flow returns to South Walnut Creek by pipeline.

2.2 SYSTEM OPERATION AND MAINTENANCE

2.2.1 Instrumentation and Controls

The collection system is automated and uses float controlled pumps. The RRS is a semi-automated system, depending primarily on pH controllers. The GAC system is controlled by the RRS discharge. The membrane cleaning cycle is controlled by a Programmable Logic Controller (PLC).

2.2.2 Electrical Supply

Electrical power to the FTU is provided by a mobile diesel generator unit rated at 250 kilowatt (kW), pending connection of plant power to the treatment unit.

2.2.3 Operational Chemicals

RRS:	Sulfuric Acid, 50%
	Lime, technical grade
	Powdered Activated Carbon
	Ferric Sulfate, technical grade
	Hydrogen Peroxide, 50%
GAC:	A-300 GAC
Generator:	Diesel Fuel

2.2.4 Personnel Protective Equipment

Personnel Protective Equipment (PPE) is worn routinely when conducting sampling or making sludge. Equipment includes tyvek coveralls, nitrile gloves, and boots. A respirator is worn during sampling of spent activated carbon. A Health and Safety Plan is in effect for system operation and maintenance.

2.2.5 System Maintenance

2.2.5.1 Collection System

Collection system maintenance consists of pump cleaning to remove accumulated debris and periodic inspection of float mechanisms and pumps (particularly after high precipitation events).

2.2.5.2 Filtration System Cleaning

Filtration system cleaning is necessary due to the porous nature of the membrane and the turbid nature of the influent. Periodic flushing with cleaning chemicals returns the membrane to full capacity. This periodic cycle takes approximately two hours to complete and generates no waste external to the process. Backflushing and chemical cleaning using hydrogen peroxide which is acidified with sulfuric acid are employed for this purpose. Two-300 gallon polyethylene tanks (TK-9 and TK-10) that hold the cleaning solutions are provided in the space beneath the filter.

The RRS is shut down during the cleaning cycle. Liquid level in the equalization tank rises during this period. For short periods, cleaning can be delayed by adding PAC to the concentration tank if solids in the tank are on the low side of the desired range. The increased scouring can temporarily maintain filtration and delay cleaning.

2.2.5.3 GAC Column Changeout

During GAC column changeout, the polishing column is moved to the lead position and a fresh column is moved to the polishing position. The columns are sized to handle at least 120 days of contaminated flow. Use of a fresh polishing column precludes discharge of contaminated water.

2.2.6 Waste Management

Process knowledge suggests that wastes be managed as low-level mixed waste pending characterization. Accordingly, management practices are implemented for requisite personnel training and supervision, waste storage, and documentation.

2.2.6.1 Personnel Training

Waste generator, inspector, and verifier training have been implemented for operating personnel in accordance with Procedures 1101, 1102 and 4034 (EG&G, 1992b; 1992c; 1992d). Waste verifiers are called to the OU2 site when the sludge press is emptied and packaging is performed.

2.2.6.2 Waste Storage Facilities

RCRA 90 Day Accumulation Area

A Resource Conservation and Recovery Act (RCRA) storage area (RCRA Unit EM1890) has been designated at the RFP and is permitted to receive drummed and labeled sludge from the RRS and spent GAC. Sludge is stored in double-lined, white, steel drums, and GAC is stored in process vessels. Appropriate forms accompany the containers until final disposal of the waste occurs.

Interim Storage Area

RCRA Unit 18.04 has been permitted to receive OU2 wastes from the 90-day area. Transportation is provided by closed truck, operated by RFP transportation personnel.

2.2.6.3 Documentation

Waste Residue Travellers (internal plant manifests) are prepared in accordance with requirements, and waste logs are maintained. Waste Stream Residue Identification and Characterization (WSRIC) documentation has been prepared (EG&G, 1993c).

Section 3

SECTION 3
TREATABILITY STUDY PROCEDURES

The approach to implementing this Treatability Study is presented in the Phase II Draft Work Plan, South Walnut Creek Basin (EG&G, 1993c). Detailed information is presented in the Phase II Field Sampling Plan (FSP) (EG&G, 1993a). Weekly and monthly samples are taken for analytes of concern including radionuclides, metals, and VOCs in accordance with the methods referenced in EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G, 1991e), which specifies sample size, preservation and holding time. Sampling is performed in accordance with Standard Operating Procedures (SOPs) and SOP Addenda which have been prepared for process water and sludge samples (EG&G, 1993a).

3.1 TREATMENT SYSTEM SAMPLING AND ANALYSIS

The sampling and analysis program allows for the measurement of process parameters at key points in the treatment process. The FTU sampling points are shown in Figure 2-1. The sampling locations, designated RS1 through RS9, are defined as follows:

- RS1 - Surface Water Collection Sumps
- RS2 - Equalization Tank Effluent
- RS3 - Reaction Tank No. 1 Effluent
- RS4 - Reaction Tank No. 2 Effluent
- RS5 - Neutralization Tank Effluent
- RS6 - Lead GAC Unit Effluent
- RS7 - Polishing GAC Unit Effluent (System Effluent)
- RS8 - Filter Press Solids Cake
- RS9 - Spent GAC (Lead Unit)

Sample points RS3 and RS4 were not sampled because a consistent effluent characterization was expected and achieved. Table 3-1 summarizes sample types, sample locations and sampling

Table 3-1

Field Treatability Study Phase II Sampling and Analysis Plan

Sample Type	Sample Locations	Sampling Frequency
Aqueous Process Samples		
VOCs	RS2	No samples taken.
	RS1, RS5, RS6, RS7	One grab sample per week.
Dissolved Metals	RS2	One grab sample per month.
	RS5	One grab sample per week.
	RS1, RS7	One composite sample per week.
Total Metals	RS2	One grab sample per month.
	RS5	One grab sample per week.
	RS1, RS7	One composite sample per week.
Dissolved Radionuclides	RS2	One grab sample per month.
	RS5	One grab sample per week.
	RS1, RS7	One composite sample per week.
Total Radionuclides	RS2	One grab sample per month.
	RS5	One grab sample per week.
	RS1, RS7	One composite sample per week.
Solids Samples		
Filter Cake (for VOCs, metals, radionuclides)	RS8	One composite sample per every two drums.
Spent GAC (for VOCs, SVOCs, metals, radionuclides, pesticides, herbicides)	RS9	One composite sample taken every changeout (approximately every four months).

frequencies at RS1 through RS9 from the FSP (EG&G, 1993a), as modified during operations. The cutoff date for analytical data (operational) contained in this report was February 1993.

3.1.1 Equalization

Sampling of the equalization tank water is conducted at the outlet at point RS2. Analytes include radionuclides and metals. Sampling and analyses at points RS1 and RS2 allow monitoring of changes which may occur during collection, transport, and equalization. Sampling at RS2 allows characterization of water influent to the RRS. Grab samples are collected for metals and radionuclides at RS1 and RS2. The data are not directly comparable. Also, sampling events for RS1 are not synchronous with the sampling events for site-wide surface water sampling. Consequently, two independent sets of data are available for source water characterization.

3.1.2 Radionuclides Removal System

Sampling is conducted at the inlet to and outlet from the RRS at points RS2 and RS5. Analytes include radionuclides, metals, and VOCs. Field parameters include turbidity and suspended solids.

3.1.3 GAC Treatment System

Sampling is conducted at the inlet to, outlet from, and in between the GAC units. Analytes include radionuclides, metals, and VOCs. Sample points are RS5 and RS6 and RS7. Analysis of VOCs was performed using EPA Methods 502.2 and 524.2.

3.1.4 Waste Stream Characterization

To manage wastes in accordance with RCRA and DOE requirements, waste streams are analyzed for hazardous and/or radioactive constituents. Characterization of waste products allows for assessment of disposal and regeneration options. Current waste management practices are based on process knowledge, pending full characterization of wastes.

3.1.4.1 Sludge

Sludge sampling is performed at RS8. Analyses include Toxicity Characteristic Leaching Procedure (TCLP) for metals and VOCs, and acid digestion for radionuclides. A Paint Filter Test is used to determine effectiveness of dewatering.

3.1.4.2 Spent GAC

Spent GAC is analyzed by TCLP for metals and VOCs and by acid digestion for radionuclides. Additional characterization is done for herbicides and pesticides, semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). The sample point is RS9.

3.2 QUALITY ASSURANCE/QUALITY CONTROL

The overall objective of the South Walnut Creek Surface Water IM/IRAP is the mitigation of downgradient contaminant migration within surface water by means of the collection and treatment of contaminated surface water to achieve, to the extent practicable, ARARS. The objective of the IM/IRAP FTU system operation is to meet the treatment goals. The results of this FTU study are intended to permit evaluation of the treatment system's ability to meet treatment goals and to characterize residues to facilitate waste management. Data users include project personnel as well as EG&G and DOE management, CDH, EPA, and the general public. Specific data quality objectives (DQOs) are identified in the Sampling and Analysis Plan (SAP) for Operation and Maintenance of the Field Treatability Unit for OU2 (EG&G, 1993d) and are summarized in Table 3-2 for sample locations RS1, RS2, RS5, RS6, and RS7.

The EPA defines five levels of analytical data (EPA, 1987 modified) associated with data quality for treatability studies. Levels III and IV are defined as follows:

- Level III - Organics and inorganics are analyzed in an off-site analytical laboratory that may or not involve contract laboratory program (CLP) procedures. The detection limits will be similar to those specified by the CLP. Level III requires rigorous quality assurance/quality control (QA/QC).

- Level IV - Analyses encompass the organic and inorganic parameters by sophisticated laboratory instrumentation such as gas chromatography/mass spectroscopy (GC/MS), atomic absorption (AA), and inductively coupled plasma (ICP). Detection limits reach the low $\mu g/\ell$ level. This analytical level also provide tentative identification of non-Hazardous Substance List parameters. Data require validation to evaluate compliance with rigorous QA/QC requirements. Level IV procedures are appropriate to develop data of known quality.

Table 3-2 specifies use of Level III and Level IV analyses to meet DQOs. CLP methods for volatile organics and metals (Level IV) are specified because these methods and associated QA/QC protocols are generally considered acceptable for use in comparing to ARARs. In addition, analytical methods referenced in the EG&G Rocky Flats GRRASP (EG&G, 1991e) are specified for radionuclides (Level III).

Precision, Accuracy, Representativeness, Completeness, and Comparability (or PARCC) are descriptors of data quality. Precision and accuracy objectives for the IM/IRA systems operation data have been evaluated on the basis of the control limits specified in the referenced analytical method and/or in data validation guidelines. For the radionuclide analyses, the accuracy objectives specified in the GRRASP methods and data evaluation protocols have been followed. Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that emphasizes the proper design of the sampling program. The field treatability study program was designed to provide representative samples through frequent sampling at each treatment process stage. A completeness goal of 90 percent was expected for the IM/IRA; that is, for each sample taken

Table 3-2

Data Quality Objectives and Sampling/Analytical Strategies

Influent Equalization Tank - Sample Point RS1

DQO:	Establish influent concentrations for all analytes. Use this data with the IM/IRA effluent data to determine performance in meeting treatment goal, and to determine the long-term impact of influent variability on treatment goals.
Activity:	Operate IM/IRA field treatability unit continuously as surface water flow requires for up to 24 hours per day. Feed the surface water to the chemical pretreatment, microfiltration and GAC units under optimized conditions. Collect periodic representative samples of the three surface weirs which provide influent flow to the Equalization Tank on a weekly basis.
EPA Analytical Levels:	Volatile organics—Level IV. Metals—Level IV. Radionuclides—Level III.

Equalization Tank Effluent - Sample Point RS2

DQO:	Establish treatability unit influent concentrations for all analytes. Use this data with the IM/IRA effluent data to determine performance in meeting treatment goals.
Activity:	Collect periodic, representative samples of the effluent from the Equalization Tank on a monthly basis.
EPA Analytical Levels:	Radionuclides—Level III Metals—Level IV Turbidity—Level II

Table 3-2 (Continued)

Neutralization Tank Effluent - Sample Point RS5

DQO: Establish chemical precipitation and microfiltration system effluent concentrations for all analytes. Use this data to determine performance in meeting treatment goals.

Activity: Collect periodic, representative samples of the effluent from the Neutralization Tank on a weekly basis.

EPA Analytical Levels:
Volatile Organics—Level IV
Metals—Level IV
Radionuclides—Level III
Turbidity—Level III
pH—Level II

Lead GAC Unit Effluent - Sample Point RS6

DQO: Establish performance of the lead GAC unit for removal of volatile organics and determine volume throughput in relation to influent concentrations of volatile organics.

Activity: Collect periodic, representative samples of the lead GAC unit effluent on a weekly basis.

EPA Analytical Levels:
Volatile Organics—Level IV

Polishing GAC Unit Effluent — Sample Point RS7

DQO: Establish the performance of the treatability unit for removal of all analytes. Use this data with the system influent data to determine performance in meeting treatment goals and to determine the impact of influent variability on treatment goals.

Activity: Collect periodic, representative samples of the polishing GAC unit effluent on a semi-weekly basis.

EPA Analytical Levels:
Volatile Organics—Level IV
Metals—Level IV
Radionuclides—Level III

Table 3-2 (Continued)

Filter Press Solids Cake — Sample Point RS8

DQO:	Determine concentrations of radioactive and hazardous constituents in filter press cake for storage and disposal.
Activity:	Collect a representative sample of the filter press solids cake during packaging activities.
EPA Analytical Levels:	TCLP Volatile organics—Level IV TCLP—Level IV Radionuclides and uranium—Level III

Spent GAC (Lead Unit) — Sample Point RS9

DQO:	Determine concentrations of radioactive and hazardous constituents in the GAC for regeneration, treatment, and disposal.
Activity:	Collect samples of carbon for analysis of background radioactivity and metals levels prior to placing unit in service. After use, obtain sample of carbon from sidestream canister for analysis of inorganic, organic and radioactive constituents.
EPA Analytical Levels:	Radionuclides—Level III TCLP Volatile Organics—Level IV TCLP Metals—Level IV

Spent Cleaning Tank Solution - Sample Point RS10

DQO:	Determine concentrations of all analytes in spent cleaning solutions to determine appropriate treatment and disposal methods.
Activity:	Collect representative samples of cleaning solutions after use for cleaning the microfiltration membranes.
EPA Analytical Levels:	Radionuclides—Level III Metals—Level IV

Table 3-2 (Continued)

Spent Flush Tank Solution - Sample Point RS11

DQO:	Determine concentrations of all analytes in spent flushing solutions to determine appropriate treatment of disposal methods.
Activity:	Collect representative samples of flushing solutions after use for cleaning the microfiltration membranes.
EPA Analytical Levels:	Radionuclides—Level III Metals—Level IV

Equalization Tank Vapor-Phase GAC - Sample Point RS12

DQO:	Determine concentrations of all analytes to determine appropriate dispositions options.
Activity:	Obtain a sample of vapor-phase GAC from the Equalization Tank vent.
EPA Analytical Levels:	TCLP Metals—Level IV TCLP Volatile Organics—Level IV

and analysis performed during the IM/IRA systems operation, the usable data points will be a least 90 percent of the theoretical amount of data points.

Comparability is a qualitative parameter that expresses the confidence with which one data set can be compared with another. To achieve comparability, the FTU sampling and analysis activities are conducted in accordance with QA/QC guidance presented in the RFP Site-Wide Quality Assurance Project Plan (QAPjP) (EG&G, 1991a), and the QAPjP Quality Assurance Addendum (QAA) 2.3 (EG&G, 1991b). The latter document was prepared to specifically address QA/QC requirements for construction, installation, and operation of the South Walnut Creek Basin FTU. The QA/QC guidance presented in these documents provides the framework for ensuring an acceptable quality of sampling and analyses during the field treatability study.

3.3 DATA MANAGEMENT

Data management is handled in accordance with protocols for field measurement, sample management, and analytical data management.

3.3.1 Field Logs

Field data recorded in logbooks include shift information, sampling event information, field data, sampling equipment calibration measurements, air sampling information, operations and maintenance (O&M) information, and waste material information.

3.3.2 Chains of Custody

Chains of custody are generated for all analytical samples. Off-site shipment of samples requires a Document Control Change Notice (DCN) to existing shipping procedures. The DCN authorizes the use of express carrier shipment, while preserving the chains of custody.

3.3.3 Rocky Flats Environmental Data System

Data is managed in accordance with the Rocky Flats Environmental Data System (RFEDs). The Data Cap subsystem provides the Sample Management Office with advice on samples, shipment, designated laboratories, and required analytes. The electronic disc deliverable permits sample tracking and facilitates laboratory contract management.

Analytical laboratory data is returned simultaneously both to RFEDs and to a data validation contractor. Samples are shipped to several off-site laboratories. Data released from RFEDs may not be totally validated. This is true for this study. Rather than delete nonvalidated data, this study has included all available data. These data are presented in Appendices A and C for process data and surface water , respectively. Data flagged with a "V" indicate validation has been completed.

Three classes of data quality are used by EG&G: (1) V — Valid and usable without qualification; (2) A — Acceptable for use with qualification(s); and (3) R — Rejected (unacceptable). Valid data meet the following objective standards, where applicable:

*1. analytical methods followed
2. acceptance criteria achieved
3. sufficient number and type of QC samples analyzed
*4. QC limits achieved
*5. compounds and analytes correctly identified
*6. equipment/instrumentation calibration criteria achieved
7. sample holding times met

* primary validation criteria

Data that are acceptable with qualifications meet most, but not all, of the above standards. At the minimum, all of the primary validation criteria are achieved within acceptable limits. Rejected data fail to meet primary validation criteria. As shown in Appendices A and C, analytical results are coded with the appropriate data qualifier (V, A, or R) based on the results of the data validation. For the purposes of the treatability study, valid and acceptable data were considered of equal utility. Rejected data have not been used in any summary tables or statistical computations. As previously mentioned, data that have not yet been validated have been used out of necessity, i.e., to provide an adequate quantity of data for conceptual analysis. Use of unvalidated data should not reduce the soundness of the conclusions drawn because most of the data that have been validated are either valid or acceptable. This is discussed further in Section 6.

Section 4

SECTION 4

TREATABILITY STUDY RESULTS AND DISCUSSION

4.1 TREATMENT SYSTEM OPERATIONS

This section discusses pertinent system operational events beginning with surface water flow collection. The RRS operational history including treatment processes, mechanical problems, and chemical usage is covered in Section 4.1.2. The GAC operational history is detailed in Section 4.1.3.

4.1.1 Surface Water Flow Collection

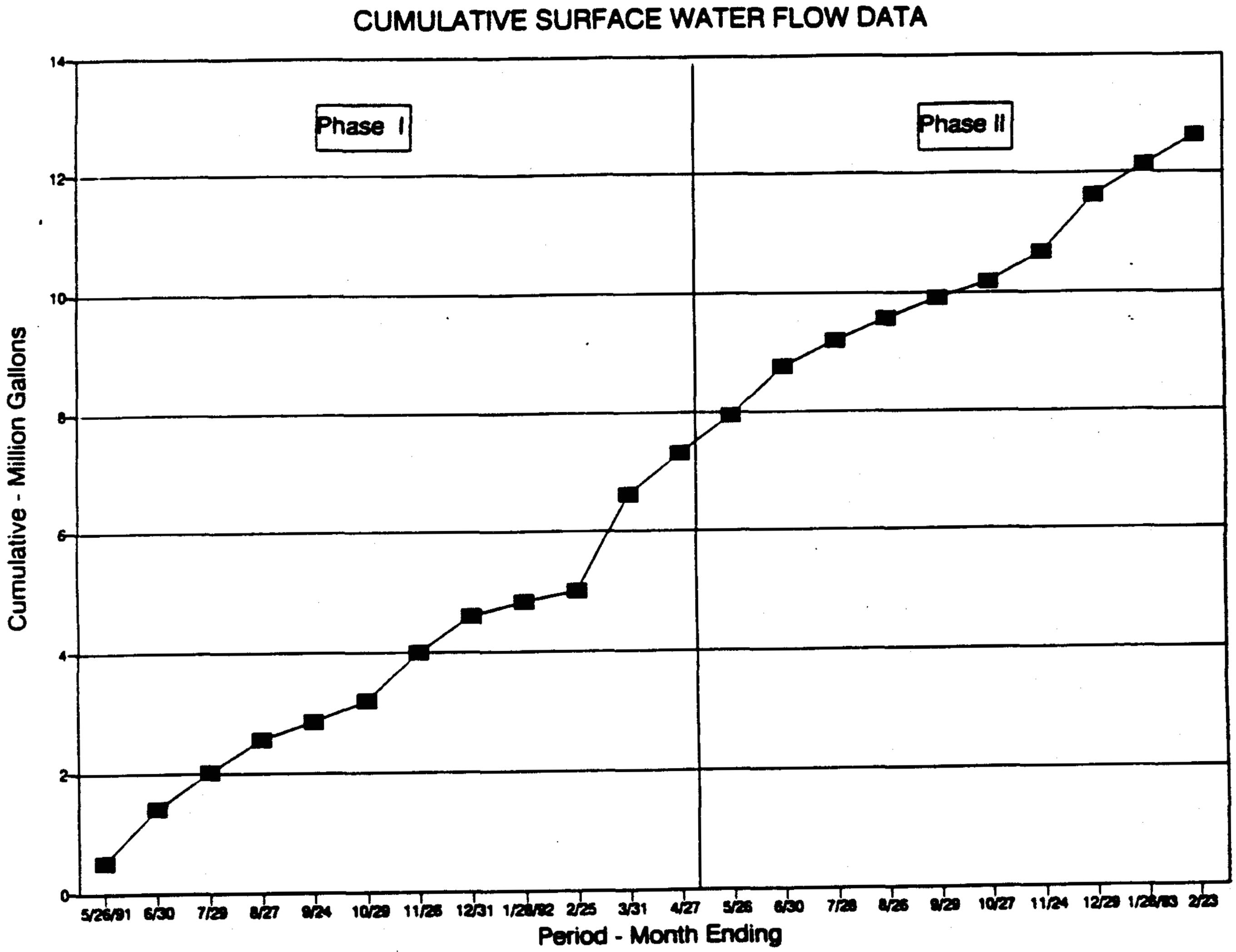
Surface water flows were collected from three concrete sumps located at SW-59, SW-61, and SW-132 along South Walnut Creek. Surface water flow from the SW-132 sump was pumped to the SW-61 sump. SW-59 sump flow was combined with SW-61 sump flow and transferred to the FTU. The cumulative monthly surface water flow data for both Phase I and Phase II are shown graphically in Figure 4-1. Cumulative surface water flow data on a weekly basis are presented in Appendix E. The data indicate a total cumulative flow of 12,756,000 gallons collected over a duration of 94 weeks or approximately 650 days (Phase I and Phase II). This equates to an average flow rate of 13.5 gallons per minute.

Influent and effluent flow rates for the FTU were recorded on a weekly basis from April 29, 1992, to April 21, 1993. Influent flow rates are not available for January 27, March 31, and April 7, 1993, and for the 7-day period following November 18, 1992. Effluent flow rate is not available for the 7-day period following November 19, 1992. The FTU influent line failed and was repaired on March 3, 1993.

Magnetic flow meters were installed at SW-59 and SW-61 in July 1992. The flow meter at SW-59 functioned intermittently from November 1992 through March 1993. SW-59 piping was

Figure 4-1

**Cumulative Surface Water Flow
Phase I and Phase II Treatability Study**



repaired in June 1992 and October 1992. The SW-59 seep location was disrupted in September 1992 by vehicle traffic. SW-132 piping was repaired in October 1992.

SW-61 flow was bypassed around the FTU for a total of 16 hours throughout Phase II due to electrical generator problems and for a total of 33 hours because of extremely high influent flow.

The total station surface water flows, surface water collection system bypasses, durations, dates, and a mass balance cannot be determined because of the limited data due to various mechanical problems, i.e., electrical generator failure, pump failure, PLC malfunction, and flow meter failure.

4.1.2 Operational History of RRS

The RRS processed approximately 5.26 million gallons of surface flow through the FTU during Phase II operations. Two days of downtime occurred from electrical generator problems, and 1 day of downtime occurred when leaking GAC vessels were taken off line. Appendix E, OU2 IM/IRA Treatment Unit Operational History, provides a weekly breakdown of RRS downtime, surface flow treated, chemical usage, membrane filter cleaning activities, sludge generation, and other operational parameters.

4.1.2.1 Total Alkalinity Reduction

Flow from the equalization tank is pumped to the first reaction tank (TK-1) and acidified by adding ferric sulfate and recycled membrane cleaning solution consisting of sulfuric acid and freshly prepared 10% sulfuric acid solution from the mixing tank. The pH at TK-1 is monitored and used to control the amount of ferric sulfate for the specified acidification. As of April 21, 1993, roughly 1,992 pounds of ferric sulfate have been used by the RRS.

During the first 3 weeks of operation, ferric sulfate was added at a dose of 15 ppm. Because of voluminous sludge production, the RRS vendor was consulted and a dose of 7.5 ppm was established. Ferric sulfate is currently added to TK-1 at a concentration determined by the influent turbidity. The turbidity meter was installed January 20, 1993. The ferric sulfate dose is now varied in accordance with Table 4-1.

Table 4-1

Ferric Sulfate Concentrations Based on Influent Turbidity

Influent Turbidity (NTU)	Ferric Sulfate Concentration (ppm)
0 - 25	7.5
26 - 50	15.0
> 50	22.5

4.1.2.2 Precipitation

Acidification in TK-1 is followed by precipitation in TK-2 as previously discussed in Section 2.1.2. The lime slurry increases the solids amount and scouring action in the membrane filter circuit. Approximately 19,350 pounds of lime have been used by the RRS as of April 21, 1993.

4.1.2.3 Sludge Generation

The slurry of precipitated, co-precipitated, and flocculated solids overflows from TK-2 into the concentration tank (TK-8) where solids form a sludge. Sludge is pumped from TK-8 to the sludge holding tank, TK-12. After a 12-hour settling period, TK-12 is bottom-pumped to the filter press. Supernatant liquid is returned to TK-8 during periods of sludge processing. After filter cake formation, the filter press is opened and sludge is dropped into 55-gallon storage drums. Sixty-three drums of sludge have been produced during Phase II to date.

RRS sludge may contain precipitated metals and radionuclides. The available characterization data presented in Appendix F is incomplete at this time; RRS sludge is being sampled, packaged, and stored as a low-level, mixed waste pending further analysis.

4.1.2.4 Crossflow Filtration and Filter Membrane Cleaning

The crossflow filtration equipment is described in Section 2.1.2. Filtration is accomplished by recirculating the slurry through the crossflow membrane and back to the concentration tank (TK-8). Treated filtrate is continuously drawn off from the filter and pumped to the neutralization tank (TK-11).

The RRS is shut down during a 2-hour filter membrane cleaning. The cleaning cycle is initiated at approximately 2-week intervals or when the filtrate flux through the membrane slows to a rate of less than 40 gpm. The cleaning schedule varies due to weather conditions but usually can be maintained during high or turbid flow conditions. The cleaning schedule is shorter during high turbidity flow conditions. Thirty-two cleaning cycles have been conducted as of April 21, 1993, during Phase II operations.

Initially, a sodium hypochlorite solution was used as a membrane cleaning chemical. This solution failed to restore the membrane after the first three cleaning cycles. Sulfuric acid was used alternately in conjunction with sodium hypochlorite for six subsequent cleaning cycles. This method was discontinued in favor of an acidified hydrogen peroxide solution due to chemical incompatibility problems. Acidified hydrogen peroxide provided adequate membrane cleaning and was used for the remainder of Phase II activities.

4.1.2.5 Filtrate Neutralization

Filtrate from the crossflow membrane filtration system is collected in TK-11. A 10-20% acid solution is added to adjust the pH to slightly above 7.0; the treated water is then pumped from the RRS into the GAC for removal of VOCs.

4.1.3 Operational History of GAC System

A new GAC vessel was installed for the Phase II program on May 1, 1992. GAC changeouts were scheduled for 120 day intervals. Pinhole leaks were discovered in the GAC vessels during the 7-day period following August 5, 1992. The leaking GAC vessels were taken off line and replaced during the 7-day period following August 26, 1992. New GAC vessels were also installed on January 16, 1993 as part of normal maintenance operations. No other GAC changeouts occurred during the remainder of Phase II operations. All spent GAC vessels are being stored as low-level mixed wastes pending further analysis.

4.2 TREATMENT SYSTEM PERFORMANCE

Treatment system performance during Phase II is presented in four subsections based on the chemical classes treated and the treatment units under consideration. Section 4.2.1 is a summary of the overall effectiveness of the FTU in treating radionuclides, VOCs, and metals in collected surface water (RS1 vs. RS7). Section 4.2.2 is a summary of the effect of the Equalization Tank (RS1 vs. RS2) on radionuclides and metals (no VOC samples were collected at RS-2). Section 4.2.3 discusses the removal of analytes by the RRS. Section 4.2.4 summarizes VOC removal in the FTU before the GAC system (RS1 vs. RS5) and by the GAC system (RS5 vs. RS7).

4.2.1 Overall FTU Performance

Tables 4-2 through 4-4 present summary statistics for all analytes with ARARs for stations RS1 (influent taken as a composite at the collection sumps), RS5 (RRS effluent/GAC influent), and RS7 (effluent), respectively. Table 4-5 further summarizes the mean analyte concentrations at these stations and presents removal percentages based on mean concentrations. The removal percentages are only rough approximations of the actual performance of the treatment system because the data for each station are not always correlated in time. Appendices A-1, A-2, and

TABLE 4-2
SUMMARY OF PROCESS WATER CHARACTERIZATION
STATION NUMBER RS1 - SURFACE WATER COLLECTION SUMPS

ANALYTE	NUMBER OF SAMPLES	NUMBER OF DETECTS > or = CRQL	MINIMUM+/-ERROR	MAXIMUM+/-ERROR	MEAN	ARAR	NUMBER ABOVE ARAR
Radiochemistry (pCi/l)							
Americium-241	31	31	0.0016+/-0.0029	0.0259+/-0.0084	0.0085	0.05	0
Gross Alpha	30	30	1.1150+/-1.3800	9.7140+/-3.9700	4.5205	11.00	0
Gross Beta	30	30	-1.2600+/-10.9000	14.7000+/-3.1900	6.6472	19.00	0
Plutonium-239/240	31	31	0.0009+/-0.0035	0.0615+/-0.0300	0.0098	0.05	1
Uranium, Total	28	28	1.8859+/-0.8416	14.7504+/-3.2790	6.3318	10.00	1
TCL Volatiles (ug/l)							
1,1-Dichloroethene	6	1	5.00 U	7.00	3.25	7	0
Carbon Tetrachloride	6	6	5.00	130.00	29.50	5	5
Chloroform	6	1	3.00 J	22.00	5.83	1	1
Tetrachloroethene	6	4	3.00 J	89.00	21.50	1	4
Trichloroethene	6	6	5.00	110.00	27.00	5	4
Vinyl Chloride	6	0	10.00 U		5.00	2	0
TCL Volatiles EPA Method 524.2 (ug/l)							
1,1-Dichloroethene	24	13	0.10 J	2.00	0.51	7	0
Carbon Tetrachloride	24	23	0.40	55.00	14.30	5	15
Chloroform	24	23	0.10 U	12.00	3.64	1	18
Tetrachloroethene	24	21	0.10 J	32.00	6.72	1	18
Trichloroethene	24	23	0.20	32.00	9.96	5	13
Vinyl Chloride	24	11	0.20 U	4.00	0.65	2	1
Dissolved Metals (ug/l)							
Iron	24	5	3.50 B	243.00	57.44	300.00	0
Manganese	24	23	4.70 B	49.40	28.03	50.00	0
Total Metals (ug/l)							
Aluminum	33	13	18.00 U	1050.00	251.36	200.00	13
Arsenic	33	0	1.00 U		0.71	50.00	0
Barium	33	0	81.90 B		144.39	1000.00	0
Beryllium	33	0	1.00 U		0.65	100.00	0
Cadmium	33	0	2.00 U		1.16	5.00	0
Chromium	33	0	2.00 U		1.96	10.00	0
Copper	33	2	2.00 U	34.10	4.61	25.00	2
Iron	33	29	12.80 U	1380.00	399.03	1000.00	3
Lead	33	2	1.00 U	12.30	1.30	5.00	1
Manganese	33	32	11.00 B	85.40	35.32	1000.00	0
Mercury	33	0	0.20 U		0.10	0.20	0
Nickel	33	0	3.00 B		3.11	40.00	0
Selenium	33	0	1.00 BN		1.67	10.00	0
Zinc	33	33	44.20	256.00	121.99	50.00	32

TCL - EPA Contract Laboratory Program Target Compound List
Mean was calculated by uniformly replacing values below the detection limit
B - For inorganics reported value is less than CRDL, but greater than IDL
E - Result is estimated

J - Reported value is less than Contract Required Detection Limit, (CRDL) but greater than Instrument Detection
N - Spike sample recovery not within control limits
U - U.S. EPA Contract Laboratory Program (CLP) CRDL
W - Post digestion spike out of control limits

TABLE 4-3
SUMMARY OF PROCESS WATER CHARACTERIZATION
STATION NUMBER RS5 - NEUTRALIZATION TANK EFFLUENT (UPSTREAM OF GAC)

ANALYTE	NUMBER OF SAMPLES	NUMBER OF DETECTS > or = CRQL	MINIMUM +/-ERROR	MAXIMUM +/-ERROR	MEAN	ARAR	NUMBER ABOVE ARAR
Radiochemistry (pCi/l)							
Americium-241	27	27	0.0000+/-0.0199	0.0099+/-0.0064	0.0039	0.05	0
Gross Alpha	24	24	-0.2050+/-1.3200	10.9800+/-3.9000	3.0275	11.00	0
Gross Beta	24	24	0.1895+/-2.9900	10.8400+/-2.5700	5.3405	19.00	0
Plutonium-239/240	26	26	-0.0015+/-0.0015	0.0268+/-0.0156	0.0027	0.05	0
Uranium, Total	24	24	0.0593+/-0.2718	9.2622+/-2.5040	3.1973	10.00	0
TCL Volatiles (ug/l)							
1,1-Dichloroethene	6	0	5.00 U		2.50	7	0
Carbon Tetrachloride	6	0	1.00 J		2.17	5	0
Chloroform	6	2	5.00 U	100.00	19.67	1	2
Tetrachloroethene	6	0	3.00 J		2.58	1	0
Trichloroethene	6	0	2.00 J		2.42	5	0
Vinyl Chloride	6	0	10.00 U		5.00	2	0
TCL Volatiles EPA Method 524.2 (ug/l)							
1,1-Dichloroethene	24	0	0.20 U		0.13	7	0
Carbon Tetrachloride	24	10	0.20 U	0.90	0.35	5	0
Chloroform	24	12	0.10	5.00	0.68	1	4
Tetrachloroethene	24	6	0.10 U	1.00	0.19	1	0
Trichloroethene	24	7	0.10	2.00	0.28	5	0
Vinyl Chloride	24	4	0.20	1.00	0.15	2	0
Dissolved Metals (ug/l)							
Iron	21	0	3.00 U		20.75	300.00	0
Manganese	23	5	1.00 U	66.10	9.07	50.00	1
Total Metals (ug/l)							
Aluminum	31	0	12.00 U		46.36	200.00	0
Arsenic	31	0	1.00 U		0.59	50.00	0
Barium	31	0	27.40 BE		64.30	1000.00	0
Beryllium	31	0	1.00 U		0.66	100.00	0
Cadmium	31	0	2.00 U		1.11	5.00	0
Chromium	31	0	2.00 U		1.87	10.00	0
Copper	31	1	2.00 U	32.60	2.40	25.00	1
Iron	31	5	2.00 UE	730.00	86.42	1000.00	0
Lead	31	0	1.00 U		0.55	5.00	0
Manganese	31	6	1.00 U	69.50	9.81	1000.00	0
Mercury	31	0	0.20 U		0.10	0.20	0
Nickel	31	0	3.00 U		2.44	40.00	0
Selenium	31	0	1.00 UW		1.93	10.00	0
Zinc	30	3	4.60 B	28.60	10.16	50.00	0

TCL - EPA Contract Laboratory Program Target Compound List
Mean was calculated by uniformly replacing values below the detection limit
B - For inorganics reported value is less than CRDL, but greater than IDL
E - Result is estimated
J - Reported value is less than Contract Required Detection Limit, (CRDL) but greater than Instrument Detection
N - Spike sample recovery not within control limits
U - U.S. EPA Contract Laboratory Program (CLP) CRDL
W - Post-digestion spike out of control limits

TABLE 4-4
SUMMARY OF PROCESS WATER CHARACTERIZATION
STATION NUMBER RS7 - SYSTEM EFFLUENT (GAC EFFLUENT)

ANALYTE	NUMBER OF SAMPLES	NUMBER OF DETECTS > or = CRQL	MINIMUM+/-ERROR	MAXIMUM+/-ERROR	MEAN	ARAR	NUMBER ABOVE ARAR
Radiochemistry (pCi/l)							
Americium-241	26	26	-0.0003+/-0.0005	0.0965+/-0.0718	0.0080	0.05	1
Gross Alpha	24	24	-1.4700+/-2.7200	6.4440+/-2.9900	1.4556	11.00	0
Gross Beta	24	24	1.2760+/-1.7800	13.0700+/-2.9500	5.4196	19.00	0
Plutonium-239/240	27	27	-0.0008+/-0.0010	0.3968+/-0.1760	0.0162	0.05	1
Uranium, Total	25	25	0.0188+/-0.2292	5.4187+/-1.6269	1.1952	10.00	0
TCL Volatiles (ug/l)							
1,1-Dichloroethene	6	0	5.00 U		2.50	7	0
Carbon Tetrachloride	6	0	5.00 U		2.50	5	0
Chloroform	6	0	5.00 U		2.50	1	0
Tetrachloroethene	6	0	5.00 U		2.50	1	0
Trichloroethene	6	0	5.00 U		2.50	5	0
Vinyl Chloride	6	0	10.00 U		5.00	2	0
TCL Volatiles EPA Method 524.2 (ug/l)							
1,1-Dichloroethene	23	0	0.20 U		0.13	7	0
Carbon Tetrachloride	23	0	0.10 J		0.16	5	0
Chloroform	23	2	0.10	0.30	0.06	1	0
Tetrachloroethene	23	0	0.10 J		0.08	1	0
Trichloroethene	23	1	0.10 U	0.20	0.09	5	0
Vinyl Chloride	23	0	0.20 U		0.10	2	0
Dissolved Metals (ug/l)							
Iron	23	0	3.00 U		20.19	300.00	0
Manganese	23	9	1.00 U	251.00	24.50	50.00	2
Total Metals (ug/l)							
Aluminum	31	4	18.00 U	425.00	93.98	200.00	4
Arsenic	31	0	1.00 U		0.80	50.00	0
Barium	31	0	24.70 BE		65.14	1000.00	0
Beryllium	31	0	1.00 U		0.69	100.00	0
Cadmium	31	0	2.00 U		1.20	5.00	0
Chromium	31	0	2.00 U		1.77	10.00	0
Copper	31	1	2.00 U	35.20	2.37	25.00	1
Iron	30	7	2.00 UE	498.00	67.00	1000.00	0
Lead	31	1	1.00 U	11.10	0.87	5.00	1
Manganese	31	14	1.00 U	256.00	24.82	1000.00	0
Mercury	31	0	0.20 U		0.10	0.20	0
Nickel	31	0	3.00 U		3.31	40.00	0
Selenium	31	0	1.00 UN		1.78	10.00	0
Zinc	30	10	4.60 B	131.00	20.46	50.00	2

TCL EPA Contract Laboratory Program Target Compound List
Mean was calculated by uniformly replacing values below the detection limit
B For inorganics reported value is less than CRDL, but greater than IDL
E Result is estimated
J - Reported value is less than Contract Required Detection Limit, (CRDL) but greater than Instrument Detection
N - Spike sample recovery not within control limits
U - U.S. EPA Contract Laboratory Program (CLP) CRDL
W - Post-digestion spike out of control limits

TABLE 4-5
OVERALL SUMMARY OF PROCESS WATER CHARCTERIZATION

ANALYTE	ARAR	RS1 - SW COLLECTION SUMP MEAN	RS1 - SW COLLECTION SUMP NUMBER ABOVE ARAR/ NUMBER SAMPLES	RS5 - GAC INFLUENT MEAN	RS5 - GAC INFLUENT NUMBER ABOVE ARAR/ NUMBER SAMPLES	RS7 - SYSTEM EFFLUENT MEAN	RS7 - SYSTEM EFFLUENT NUMBER ABOVE ARAR/ NUMBER SAMPLES	MEAN REMOVAL EFFICIENCY (%) RS1 v RS5	MEAN REMOVAL EFFICIENCY (%) RS5 v RS7	MEAN REMOVAL EFFICIENCY (%) RS1 v RS7
Radiochemistry (pCi/l)										
Americium-241	0.05	0.0085	0/31	0.0039	0/27	0.0080	1/26	54	*	5.9
Gross Alpha	11.00	4.5205	0/30	3.0275	0/24	1.4556	0/24	33	52	67.8
Gross Beta	19.00	6.6472	0/30	5.3405	0/24	5.4196	0/24	19.7	*	18.5
Plutonium-239/240	0.05	0.0098	1/31	0.0027	0/26	0.0162	1/27	72.4	*	*
Uranium, Total	10.00	6.3318	1/28	3.1973	0/24	1.1952	0/25	49.5	62.6	81.1
TCL Volatiles (ug/l)										
1,1-Dichloroethene	7	3.25	0/6	2.50	0/6	2.50	0/6	23	0	23
Carbon Tetrachloride	5	29.50	0/6	2.17	0/6	2.50	0/6	92.6	*	91.5
Chloroform	1	5.83	1/6	19.67	2/6	2.50	0/6	*	87.3	57.1
Tetrachloroethene	1	21.50	4/6	2.58	0/6	2.50	0/6	88	3.1	88.4
Trichloroethene	5	27.00	4/6	2.42	0/6	2.50	0/6	91	*	90.7
Vinyl Chloride	2	5.00	0/6	5.00	0/6	5.00	0/6	0	0	0
TCL Volatiles EPA Method 524.2 (ug/l)										
1,1-Dichloroethene	7	0.51	0/24	0.13	0/24	0.13	0/23	74.5	0	74.5
Carbon Tetrachloride	5	14.30	15/24	0.35	0/24	0.16	0/23	97.6	54.3	98.9
Chloroform	1	3.64	18/24	0.68	4/24	0.06	0/23	81.3	91.2	98.4
Tetrachloroethene	1	6.72	18/24	0.19	0/24	0.08	0/23	97.2	57.9	98.8
Trichloroethene	5	9.96	13/24	0.28	0/24	0.09	0/23	97.2	67.9	99.1
Vinyl Chloride	2	0.65	11/24	0.15	0/24	0.10	0/23	76.9	33.3	84.6
Dissolved Metals (ug/l)										
Iron	300.00	57.44	0/24	20.75	0/21	20.19	0/23	63.9	2.7	64.9
Manganese	50.00	28.03	0/24	9.07	1/23	24.50	2/23	67.6	*	12.6
Total Metals (ug/l)										
Aluminum	200.00	251.36	13/33	46.36	0/31	93.98	4/31	81.6	*	62.6
Arsenic	50.00	0.71	0/33	0.59	0/31	0.80	0/31	16.9	*	*
Barium	1000.00	144.39	0/33	64.30	0/31	65.14	0/31	55.5	*	54.9
Beryllium	100.00	0.65	0/33	0.66	0/31	0.69	0/31	*	*	*
Cadmium	5.00	1.16	0/33	1.11	0/31	1.20	0/31	4.3	*	*
Chromium	10.00	1.96	0/33	1.87	0/31	1.77	0/31	4.6	5.3	9.7
Copper	25.00	4.61	2/33	2.40	1/31	2.37	1/31	47.9	1.2	48.6
Iron	1000.00	399.03	3/33	86.42	0/31	67.00	0/30	78.3	22.5	83.2
Lead	5.00	1.30	1/33	0.55	0/31	0.87	1/31	57.7	*	33.1
Manganese	1000.00	35.32	0/33	9.81	0/31	24.82	0/31	72.2	*	29.7
Mercury	0.20	0.10	0/33	0.10	0/31	0.10	0/31	0	0	0
Nickel	40.00	3.11	0/33	2.44	0/31	3.31	0/31	21.5	*	*
Selenium	10.00	1.67	0/33	1.93	0/31	1.78	0/31	*	7.8	*
Zinc	50.00	121.99	32/33	10.16	0/30	20.46	2/30	91.7	*	83.2

* In these cases, mean effluent concentrations exceed mean influent concentrations. This indicates removal of the analyte is not occurring and should not imply that the the analyte is being added to the water by way of treament.
This "error" is due to the quantitation of low concentrations of analytes and/or the inherent error of comparative analysis using mean concentrations.

A-3 present summary statistics of FTU process data (analytes with ARARs) at each station for radionuclides, metals, and VOCs, respectively. Appendices B-1, B-2, and B-3 present concentration vs. time graphs for these process data.

It should be noted that actual influent water samples were not collected at RS-1 as specified in the FSP. Rather, composite samples for volatiles, radionuclides, and dissolved and total metals were collected at the surface water sources. Because it is not recommended that composite samples be collected for VOCs (due to volatilization), and because RS-1 data are composite samples from the sources and not actually from the influent, the data are presented for informational purposes and should be interpreted recognizing these major qualifications. The error in sampling procedures has been corrected. Data from process water sample locations RS-2 through RS-7 were collected in accordance with appropriate SOPs.

4.2.1.1 Radionuclide Removal

The influent and effluent treatment system data indicate radionuclides contributing to gross alpha activity were removed as was uranium (refer to corresponding figures in Appendix B-1). Gross alpha activity was reduced by 67.8% whereas uranium removal was 81.1% (Table 4-5). The data do not show obvious removal of other radionuclides because influent concentrations were low. In terms of ARARs, one plutonium-239/240 FTU effluent (RS7) sample was above ARAR; however, the corresponding FTU influent (RS1) sample was below ARAR. One americium-241 FTU effluent (RS7) sample was above ARAR, but, none of the FTU influent samples (RS1) were above ARAR.

4.2.1.2 VOC Removal

The influent and effluent treatment system data indicate that volatiles are effectively removed (Table 4-5). Based on EPA Method 524.2 data (low detection limits), the range of VOC removal is 74.5% (1,1 DCE) to 99.1% (TCE). With respect to ARARs, carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, and vinyl chloride exhibited concentrations above

ARARs at RS1 (Tables 4-2 and 4-5). No VOC analytes exceeded ARARs at RS7 (Tables 4-4 and 4-5). All RS7 analytes except chloroform and trichloroethene were either not detected or exhibited estimated values below the Contract Required Detection Limit (CRDL).

4.2.1.3 Metals Removal

Metal removal efficiencies vary from 0% to as high as 83.2% (Table 4-5). Metals with the highest removal efficiency ($\approx$50% to 83.2%) include aluminum, barium, copper, iron, and zinc. Metals with low removal efficiencies are chromium, lead, and manganese (9.7% to 33.1%). The data do not indicate any removal of arsenic, beryllium, cadmium, nickel, and selenium. With respect to ARARs, aluminum, copper, iron, lead, and zinc concentrations were above ARARs at RS1. Aluminum, copper, lead, manganese, and zinc concentrations were only rarely above ARARs at RS7, and the mean concentrations were all below ARARs.

4.2.2 Equalization Tank

Section 4.2.2 discusses removal of radionuclides and metals from collected surface waters by the equalization tank. Removal of these analytes would occur from particle settling and adhesion to the tank walls. No VOC samples were collected at RS2.

4.2.2.1 Radionuclide Removal

Graphs of radionuclide concentrations vs. time for RS1 and RS2 (Appendix B-1) do not indicate significant removal of radionuclides across the equalization tank. Although there is considerable "noise" in the data presentation, each graph appears to indicate some radionuclide removal is occurring. Table 4-6 shows there were only rare exceedances of ARARs at RS1 and RS2.

Table 4-6

Summary of Radionuclides Exceeding ARARs for RS1 and RS2

Analyte	ARAR (pCi/ℓ)	Sample Location RS1[1] (pCi/ℓ)	Sample Location RS2[2] (pCi/ℓ)	Sample Date
Total Pu-239/240	0.05	0.0615 +/-0.03	0.0084 +/-0.0058	06/02/92
Total Uranium	10.00	14.7504 +/-3.279	NA	06/16/92

NA = Not Available, RS2 sampled monthly, RS1 sampled weekly.
[1] = RS1 collected from surface water collection sumps and therefore represents influent to the Equalization Tank.
[2] = RS2 is effluent from the Equalization Tank.

Table 4-7

Summary of Metals Exceeding ARARs for RS1 and RS2

Analyte	ARAR (μg/ℓ)	Sample Location RS1[1] (μg/ℓ)	Sample Location RS2[2] (μg/ℓ)	Sample Date
Dissolved Manganese	50.00	28.60	81.80	07/21/92
			64.20	11/03/92
		20.50		
Total Aluminum	200.00	346.00	127.00	05/26/92
		594.00	86.40	06/02/92
		391.00	79.70	06/09/92
		281.00	NA	06/16/92
		1,040.00	NA	10/27/92
		1,050.00	1,280.00	11/03/92
		423.00	NA	11/24/93
		421.00	NA	12/01/92
		212.00	58.80	12/21/92
		248.00	NA	01/26/93
		371.00	NA	02/02/93
		238.00	NA	02/09/93
Total Copper	25.00	34.10	33.90	05/05/92
		25.20	NA	12/01/92
Total Iron	1,000.00	1,340.00	NA	10/27/92
		1,340.00	1,540.00	11/03/92

Table 4-7 (Continued)

Summary of Metals Exceeding ARARs for RS1 and RS2

Analyte	ARAR (µg/ℓ)	Sample Location RS1[1] (µg/ℓ)	Sample Location RS2[2] (µg/ℓ)	Sample Date
Dissolved Manganese	50.00	28.60	81.80	07/21/92
		20.50	64.20	11/03/92
Total Zinc	50.00	137.00	122.00	05/05/92
		110.00	81.70	05/19/92
		163.00	107.00	05/26/92
		139.00	109.00	06/02/92
		202.00	131.00	06/09/92
		187.00	NA	06/16/92
		200.00	NA	06/23/92
		256.00	NA	07/07/92
		130.00	NA	07/14/92
		215.00	162.00	07/21/92
		151.00	NA	07/28/92
		115.00	54.10	08/04/92
		73.20	63.40	08/28/92
		76.20	40.30	10/12/92
		131.00	NA	10/20/92
		133.00	NA	10/27/92
		91.00	103.00	11/03/92
		61.60	NA	11/10/92
		117.00	NA	11/24/92
		123.00	NA	12/01/92
		79.40	NA	12/08/92
		108.00	NA	12/15/92
		112.00	84.10	12/21/92
		73.20	NA	12/28/92
		95.30	74.70	01/05/93
		95.30	NA	01/19/93
		88.20	NA	01/26/93
		101.00	NA	02/02/93
		117.00	NA	02/09/93

NA = Not Available, RS2 sampled monthly, RS1 sampled weekly.
[1] = RS1 collected from surface water collection sumps and therefore represents influent to the Equalization Tank.
[2] = RS2 is effluent from the Equalization Tank.

4.2.2.2 Metals Removal

Review of the concentration vs. time graphs for the metals (Appendix B-2) indicates little if any removal of metals across the equalization tank. With respect to ARARs, there are many occurrences of analytes exceeding ARARs at either RS1 or RS2, particularly for aluminum and zinc (Table 4-7). These data (Table 4-7) also indicate some aluminum and zinc removal is occurring across this unit.

4.2.3 Radionuclides Removal System

4.2.3.1 Radionuclides Removal

The concentration vs. time graphs for radionuclides at RS2 and RS5 (Appendix B-1) indicate plutonium and to a lesser extent americium and uranium are removed by the RRS (refer also to Table 4-5, RS1 vs. RS5). Although such removal is expected, the low overall removal (Table 4-5, RS1 vs. RS7) of plutonium and americium across the entire treatment system renders any conclusion about radionuclide removal by the RRS suspect. Also note there is apparent significant removal of uranium across the GAC units (Table 4-5, RS5 vs. RS7). Such removal by GAC is unexpected but nevertheless contributes to the high overall uranium removal by the treatment system. No radionuclides exceeded ARARs in the RRS influent (RS2) or RRS effluent (RS5).

4.2.3.2 Metals Removal

The concentration vs. time graphs for metals at RS2 and RS5 (Appendix B-1) indicate some metals are removed by the RRS, particularly aluminum, barium, iron, lead, manganese, and zinc. Removal efficiencies for these metals range from 55.5% (barium) to 91.7% (zinc). Other metals were removed to a lesser extent, and there is no apparent removal of beryllium or selenium. All metals which had RS2 values greater than ARAR were reduced to below ARARs at RS5 by the RRS, except for copper which showed only a slight decrease (Table 4-8).

Table 4-8

Summary of Metals Exceeding ARARs for RS2 vs. RS5

Analyte	ARAR (µg/ℓ)	Sample Location RS2[1] (µg/ℓ)	Sample Location RS5[2] (µg/ℓ)	Sample Date
Dissolved Manganese	50.00	81.80	20.50	07/21/92
		64.20	5.60	11/03/92
Total Aluminum	200.00	1,280.00	22.60	11/03/92
Total Copper	25.00	33.90	32.60	05/05/92
Total Iron	1000.00	1,540.00	730.00	11/03/92
Total Zinc	50.00	122.0	25.20	05/05/92
		81.70	14.90	05/19/92
		107.00	14.30	05/26/92
		109.00	8.60	06/02/92
		131.00	15.40	06/09/92
		162.00	8.50	07/21/92
		54.10	11.90	08/04/92
		63.40	5.90	08/28/92
		103.00	28.60	11/03/92
		84.10	4.80	12/21/92
		74.70	10.20	01/05/93

[1] = RS2 is effluent from the Equalization Tank and influent to the RRS.
[2] = RS5 is effluent from the RRS.

4.2.4 VOC Removal

EPA CLP Method 502.2 and EPA Method 524.2 were used to analyze samples from the influent line to the GAC system (RS5) and from the GAC system discharge (RS7) to the South Walnut Creek drainage. The EPA CLP method lacked enough sensitivity to distinguish the low VOC concentrations in the process water; consequently, most of the values reported by the CLP method were at the CRDL.

4.2.4.1 VOC Removal Before GAC System

Data resulting from the use of EPA Method 524.2 indicate significant VOC removal prior to treatment by GAC (Table 4-5). Removal of VOCs presumably occurs by volatilization via aeration/mixing that occurs in the process lines, the equalization tank, and the RRS. With respect to ARARs, carbon tetrachloride, chloroform, tetrachloroethane, and trichloroethene were detected above ARARs at RS1. 1,1-Dichloroethene had only one detect at the ARAR level at RS1 using the CLP method at RS1 and RS5. Chloroform was the only VOC analyte that had a value greater than ARAR at RS5.

4.2.4.2 VOC Removal in GAC System

GAC further removes residual VOCs present after treatment by the RRS (Appendix B-3 and Table 4-5). There are no exceedances of ARARs for VOCs in the effluent from the GAC, whereas, there were 4 of 25 exceedances of ARAR for chloroform in the influent to the GAC. Although VOC removal occurs in the GAC units, it is worthy to note that, with the exception of chloroform, the organics did not exceed ARAR in the influent to the GAC.

4.3 COST ANALYSIS

Treatability study costs for Phase II are presented in Table 4-9. Included in the table are capital costs, operations and maintenance costs, and analytical services costs. Capital costs include the design, fabrication, delivery, installation, and startup of the RRS. The Phase I system included the collection system (for SW-59 and SW-61), the equalization tank and GAC system. The cost for Phase I capital equipment and operations is not included in this cost analysis. The Phase II system incorporated the RRS and collection of SW-132. Operations and maintenance includes daily operation of the system based on a 24 hr/day, 7 days/week schedule. Operating costs include treatment system operation (labor), process chemicals requirements, sampling (labor, materials, and sample shipping), record keeping, vehicle and machinery rental, office trailer rental, personnel protective equipment requirements, chemical spill response (labor and treatment costs) and sludge production and storage. Maintenance costs include treatment system maintenance and repairs, generator servicing and repairs, repair supplies, and generator diesel fuel requirements. Analytical services costs include those for laboratory analyses and data validation.

The costs presented in Table 4-9 are estimates and are conservatively low. EG&G labor is not included in the capital or operation and maintenance estimates. The total cost of capital (not amortized) and other costs for Phase II is $2,115,000. The Phase II costs are based on a reporting period from 27 April 1992 to 2 March 1993.

Table 4-9

Phase II Treatability Cost Summary

Item	Cost-Phase II
Capital	$ 950,000
Operations and Maintenance	$1,100,000
Analytical Services	$ 654,000
Total Costs	$2,115,000

4.3.1 Water Treatment Costs

Costs for treating a unit volume of water or for removing a unit mass of analyte have been estimated (Table 4-10). Mass removals were estimated using mean influent and effluent concentration data and the total volume of water processed during Phase II. The mass of sludge produced and GAC used was obtained from the operational history (Appendix E). The total costs of Phase II are listed in Table 4-10. Cost per unit mass of analyte removed was calculated by dividing the total cost by the mass of analytes removed. Unit costs for operation include $402/1,000 gallons water treated, $14,100 per gram of total radionuclides removed, $153 per gram of total metals removed, and $3,000 per gram of total VOCs removed.

4.3.2 Residuals Costs

Residuals include primarily ferric hydroxide sludge and spent GAC. Approximately 26,000 pounds of sludge and 6,000 pounds of spent GAC were produced during the Phase II reporting period. This material is being managed as a low-level, mixed waste. Costs associated with this waste include packaging, handling, monitoring, and transporting the wastes to RFP interim storage areas, in accordance with RCRA requirements. The cost of temporarily storing these residuals for up to 30 years (pending availability of a permanent treatment, storage, or disposal [TSD] facility) has not yet been determined. Final treatment and/or disposal is anticipated to cost $2,000 per 55-gallon drum of sludge disposed and $0.50 to $1.00 per pound of GAC regenerated. Total cost for final treatment and/or disposal is anticipated to be $130,000 based on the current inventory of sludge and GAC generated during the Phase II reporting period ($124,000 for sludge and $6,000 for GAC).

Other forms of residuals include contaminated PPE, generator solid wastes, and air emissions from the diesel fuel burned by the generator. Diesel fuel consumption has averaged

Table 4-10

Treatment Costs and Residuals Production for Phase II

	Total RADS[a] (pCi/ℓ)	Total Metals (μg/ℓ)	Total VOCs (μg/ℓ)
Average Concentration In	6.3318	967.36	35.78
Average Concentration Out	1.1952	284.29	0.62
Change in Concentration	5.1366	683.07	35.16
Gallons Water Treated	5,260,000	5,260,000	5,260,000
	(grams)	(grams)	(grams)
Mass of Analytes Removed	150	13,800	708
Mass of Sludge Produced (pounds)	26,000	26,000	
Mass of Carbon Used (pounds)			6,000
Pounds Sludge/gram RADs Removed	173		
Pounds Sludge/gram Metals Removed		1.9	
Pounds GAC Used/gram VOC Removed			8.5
Total Cost of Phase II	2,115,000		
Capital-RRS	950,000		
Capital-GAC	Phase I Cost		
Other Costs	1,165,000		
Costs ($)/1,000 Gallons Water Treated	402		
Cost ($) per gram Total RADs Removed	14,100		
Cost ($) per gram Total Metals Removed		153	
Cost ($) per gram Total VOCs Removed			3,000

[a] Mass of Radionuclides removed is due primarily to uranium removal.

approximately 1,200 gallons/week since the beginning of Phase II. Associated air emissions per 1,000 gallons of diesel fuel consumed are estimated* to be:

Particulates	33.5	lbs
SO_x	31	lbs
NO_x	469	lbs
VOCs	32	lbs
CO	102	lbs

* EPA. 1990

4.3.3 Cost Effectiveness

The high unit costs for analyte removal cited in Section 4.3.1 portray a treatment system that is not cost effective to operate. The high unit costs are largely a result of low influent analyte concentrations and thus low analyte mass removal rates. Also, in terms of improvement of water quality with respect to radionuclides, there is no benefit from treatment because greater than 99% of the radionuclides removed is attributed to uranium, which is not above ARAR in the influent.

Higher influent concentrations, particularly radionuclides, will result in a more cost-effective operation. The unit costs are expected to decrease in approximate proportion to increases in analyte concentrations because (1) the capital cost is fixed, and (2) the labor, analytical and chemical usage costs should not increase significantly with higher influent analyte concentrations. On the other hand, there will be increased costs for activated carbon changeouts with increasing influent VOC concentrations. There is insufficient data to determine whether this treatment system is less cost effective to operate than other potentially effective and implementable treatment systems or even other compatible (in terms of analyte removal) treatment systems existing at the RFP. In the latter case, it should be noted that the ability of the OU1 IM/IRA treatment system to remove plutonium and americium is uncertain and unknown, and that flash evaporators per se (Building 374 and the solar pond treatment system) do not remove VOCs.

removing the analytes identified in Table 1-1 to ARAR levels. Higher influent analyte concentrations will result in lower unit costs for analyte removal.

Section 5

SECTION 5
SURFACE WATER SOURCES CHARACTERIZATION

The purpose of this section is to evaluate the quality of the surface water being collected for treatment. Surface water quality at SW-59, SW-61 and SW-132 are separately evaluated. Compliance with ARARs is the main criterion used to assess surface water quality.

5.1 SURFACE WATER SOURCES SAMPLING AND ANALYSIS

South Walnut Creek water is sampled routinely as part of the site-wide surface water monitoring program at SW-59, SW-61, and SW-132. Surface water was collected from SW-59 and SW-61 throughout Phase I and Phase II. The surface water chemical characterization of these sources is based on data available from May 1991 (beginning of Phase I) to September 1993. Although surface water data exist for the time preceeding May 1991, collection and treatment of surface water had not yet begun. Prior to May 1991, SW-59 was allowed to run into SW-61. The intent of the surface water chemical characterization is to characterize the sources based on current conditions.

Surface water was also collected from SW-132 upon implementation of the Phase II program. However, in September of 1993 it was determined that SW-132 was not always sampled in the same location; occasionally samples were collected from within the culvert (correct location), and at other times samples were taken from within the drainage near the culvert outlet. Records are poor regarding the exact sample location. Therefore, weekly samples were taken from within the culvert from September 7, 1993, to September 20, 1993, in order to characterize surface water quality at SW-132. Only these SW-132 data are presented in this report.

Grab samples from the OU2 seep and stream locations were taken monthly since 1990 as part of the site-wide monitoring program, and semi-monthly since August 1992 at the request of the OU2 Project Manager. Sampling and sample handling were conducted in accordance with the

QAPjP. These surface water samples were analyzed in accordance with the GRRASP. The surface water samples were not necessarily collected on the same dates as the treatment system influent samples. As a result, the data from the two programs are not directly comparable.

5.2 SURFACE WATER SOURCES CHARACTERIZATION

5.2.1 Surface Water Flow Rates

Total flow to the treatment system has been measured since May 1991 (refer to Section 4.1.1.). Since flow measurements were not taken at each station, it is assumed that the average annual flows at each source that are cited in the IRAP (DOE, 1991) are still applicable. They are as follows:

Station	Flow (gpm)
SW-59	1
SW-61	14
SW-132	5
Total	20

It is noted that, based on the total volume of surface water collected for treatment, the average flow of surface water collected since the treatability study was initiated in May 1991 is approximately 13.5 gpm. The flow contributed from SW-59 was approximately 7% during the time this flow was measured which equates to approximately 1 gpm. This value indicates that the flow cited in the IRAP for SW-59 is a reasonable estimate of the current flow. With the exception of the limited flow data collected for SW-59, flow rates have not been measured at the individual sources.

5.2.2 Determination of Surface Water Analytes of Concern

The IRAP identified specific analytes of concern in surface water based on their concentrations relative to ARARs. These analytes are presented in Table 1-1. The presence of these analytes at concentrations in excess of ARARs was the basis for design for the IM/IRA. Based on chemical usage and the nature of the RFP historical mission, the presence of organics (particularly chlorinated solvents), plutonium, americium, and uranium on the list of analytes of concern is not surprising. Because most VOCs that are analyzed in surface and groundwater at the RFP are of anthropogenic origin, VOC data from the surface water sources were reviewed to check for the presence of other analytes not listed in Table 1-1. These analytes are shown in Table 5-1 and represent VOCs either previously undetected or for which an ARAR had not been identified. As can be seen from Table 5-1, only a few of the "additional" VOCs have a potential ARAR at this time based on a review of current federal and state water quality standards. This review of water quality standards also indicates the ARARs identified in Table 1-1 are still applicable at the time of this writing. Data for all VOCs detected at the surface water sources as well as the metals and radionuclides identified in Table 1-1 are summarized and compared to ARARs in Section 5.2.3.

5.2.3 Surface Water Characterization

This section summarizes the results of the chemical characterization for the three surface water sources (Stations SW-59, SW-61, and SW-132). Each of the sources have been sampled and analyzed for EPA's Target Compound List (TCL) VOCs, radionuclides, total and dissolved EPA (Target Analyte List [TAL]) metals, and selected metals not included on the EPA TAL (cesium, lithium, molybdenum, silicon, strontium, and tin). However, as discussed in Section 5.2.2, only a subset of these analytes have ARARs (Tables 1-1 and 5-1). The following summary is focused on only those analytes for which ARARs have been identified. The complete sample collection and analytical data for all analytes at these three locations is presented in Appendix C.

Table 5-1

Surface Water
Volatile Organic Compounds
Previously Unidentified in IM/IRAP

Compound	ARAR ($\mu g/\ell$)
Acetone	NI
Bromodichloromethane	100[1,2]
2-Butanone	NI
1,2-Dichloroethane	NI
1,2-Dichloroethene	NI
2-Hexanone	NI
Methylene Chloride	5[1]
4-Methyl-2-Pentanone	NI
Toluene	1,000[1]
1,1,1-Trichloroethane	200[1]
Total Xylenes	10,000[1]

1 Safe Drinking Water Act Maximum Contaminant Level.
2 Based on trihalomethane standard of less than 100 $\mu g/\ell$ all trihalomethanes (Total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane).

NI: Not identified based on a review of federal and state water quality standards.

The analytical data for surface water stations have been subjected to QA/QC validation procedures which are described in detail in Section 6. Summary statistics have been prepared using a data set consisting of all available data (excluding rejected data). Non-validated data have been used for completeness, and their inclusion is not expected to significantly change the reported results because most of the data have been validated and found to be valid or acceptable (see Section 6). Summary statistics for Stations SW-59, 61, and 132 are presented in Tables 5-2, 5-3, and 5-4, respectively. Each table presents the number of samples and the number of results exceeding the method detection limit for each analyte of concern, followed by the minimum and maximum detected value, and the arithmetic mean value. ARARs, and the number of samples at or above the ARAR are also presented to assess the degree of compliance with ARARs.

It should be noted that the method detection limits for chloroform, tetrachloroethene, and vinyl chloride (5 $\mu g/\ell$, 5 $\mu g/\ell$, and 10 $\mu g/\ell$, respectively) exceed each compound's respective ARARs (1 $\mu g/\ell$, 1 $\mu g/\ell$, and 2 $\mu g/\ell$). It is not possible to determine the number of samples exceeding the ARAR unless all concentrations exceed the detection limit. Note also that a comparison of mean concentrations with ARARs for each of these analytes is only valid when all concentrations exceed the detection limit. This is because mean concentrations were calculated by applying values equivalent to one-half the detection limit for results below the method detection limit.

5.2.3.1 Surface Water Station SW-59

Radionuclides: ARARs for total americium-241 and plutonium-239/240 were exceeded in 4 of 27 ; and 3 of 29 samples, respectively. Gross alpha and beta and total uranium results indicate no exceedances of their respective ARARs. It is noted that the mean value for all radionuclides is below its respective ARAR value.

Volatile Organic Compounds: Although all of the VOCs with ARARs were detected at least once, the concentrations of carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene consistently and significantly exceeded their respective ARARs.

TABLE 5-2
SUMMARY OF SURFACE WATER CHARACTERIZATION
WITH SUMMARY STATISTICS FOR ANALYTES OF CONCERN
USING ALL AVAILABLE NON-REJECTED DATA
STATION NUMBER SW-059

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
Total Radiochemistry (pCi/l)												
AMERICIUM-241 (Total)	27	18	-.004 +/- .01	U	V	.12 +/- .024		A	0.0192	0.05	4	14.81
GROSS ALPHA (Total)	29	22	-.264 +/- 1.28	J		21 +/- 2.5		A	4.5236	11	2	6.9
GROSS BETA (Total)	29	24	1.3 +/- 1.2	U		17 +/- 3.3		V	5.161	19	0	0
PLUTONIUM-239 (Total)	1	1	.024 +/- .012		A	.024 +/- .012		A	0.024	0.05	0	0
PLUTONIUM-239/240 (Total)	29	19	0 +/- 0.004	U		.16 +/- .026		V	0.0223	0.05	3	10.34
TOTAL URANIUM (Total)	27	27	1.49633			2.93333			2.2052	10	0	0
Total Metals (ug/l)												
ALUMINUM (Total)	41	37	17.4	B	JA	3950		V	619.58	200	22	53.66
ARSENIC (Total)	39	5	.7	U	JA	4.3		JA	0.93	50	0	0
BARIUM (Total)	41	40	84.6		V	211		V	168.5	1000	0	0
BERYLLIUM (Total)	41	2	.3	U	V	1.2		JA	0.44	100	0	0
CADMIUM (Total)	41	0	1	U	V	4.4	U	V	NA	5	0	0
CHROMIUM (Total)	41	4	2	U	V	26.6		JA	2.51	10	1	2.44
COPPER (Total)	40	17	1.9	U	JA	7.4			3.33	25	0	0
IRON (Total)	41	38	9.5	U	JA	3770	*	JA	507.69	1000	5	12.2
LEAD (Total)	40	23	.8	U	V	13.7		JA	2.17	5	5	12.5
MANGANESE (Total)	41	38	1.5	U	V	78.8	E	JA	15.87	1000	0	0
MERCURY (Total)	41	5	.1	U	V	.53		JA	0.12	0.2	5	12.2
NICKEL (Total)	40	3	2.6	U	JA	36.5	V		5.77	40	0	0
SELENIUM (Total)	41	9	.7	U	JA	3.1		JA	1.04	10	0	0
ZINC (Total)	41	41	72.1		V	400		V	232.39	50	41	100
Filtered Metals (ug/l)												
IRON (Filtered)	40	14	2	UE	V	1550	V		55.82	300	1	2.5
MANGANESE (Filtered)	41	25	1	U	V	111	V		8.85	50	1	2.44

Notes:
- Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
- In calculating the mean, one-half the detection limit is used for non-detects; if the detection limit is greater than 2 times the CRQL, the data point is not used.
- Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit; B - Organics:present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off-scale in both columns
- Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

TABLE 5-2 (Continued)
SUMMARY OF SURFACE WATER CHARACTERIZATION
WITH SUMMARY STATISTICS FOR ANALYTES OF CONCERN
USING ALL AVAILABLE NON-REJECTED DATA
STATION NUMBER SW-059

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR		No. ≥ ARAR	% ≥ ARAR
Volatile Organics (ug/l)													
1,1,1-TRICHLOROETHANE	42	40	4	J	A	20		V	10.14	200		0	0
1,1,2,2-TETRACHLOROETHANE	42	0	5	U	V	5	U	V	NA			NA	NA
1,1,2-TRICHLOROETHANE	42	0	5	U	V	5	U	V	NA			NA	NA
1,1-DICHLOROETHANE	42	20	1	J	A	6	DJ		3.12			NA	NA
1,1-DICHLOROETHENE	42	32	1	J	A	11		V	4.76	7		12	28.57
1,2-DICHLOROETHANE	41	4	1	J	A	5		V	2.52			NA	NA
1,2-DICHLOROETHENE	41	40	5	U	V	130		V	60.62			NA	NA
1,2-DICHLOROPROPANE	42	0	5	U	V	5	U	V	NA			NA	NA
2-BUTANONE	39	1	7	J	A	7	J	A	5.05			NA	NA
2-HEXANONE	41	1	3	J	A	3	J	A	4.95			NA	NA
4-METHYL-2-PENTANONE	41	1	5	J	A	5	J	A	5.0			NA	NA
ACETONE	38	2	7	JB		43	JA		5.82			NA	NA
BENZENE	42	0	5	U	V	5	U	V	NA			NA	NA
BROMODICHLOROMETHANE	41	1	.6	J		.6	J		2.45	100	U	0	0
BROMOFORM	41	0	5	U	V	5	U	V	NA			NA	NA
BROMOMETHANE	40	0	10	U	V	10	U	V	NA			NA	NA
CARBON DISULFIDE	41	0	5	U	V	5	U	V	NA			NA	NA
CARBON TETRACHLORIDE	42	42	16		V	200	D	V	110.76	5		42	100
CHLOROBENZENE	42	0	5	U	V	5	U	V	NA			NA	NA
CHLOROETHANE	42	0	10	U	V	10	U	V	NA			NA	NA
CHLOROFORM	42	42	5		V	34		V	19.19	1	•	42	100
CHLOROMETHANE	41	0	10	U	V	10	U	V	NA			NA	NA
DIBROMOCHLOROMETHANE	41	0	5	U	V	5	U	V	NA			NA	NA
ETHYLBENZENE	42	0	5	U	V	5	U	V	NA			NA	NA
METHYLENE CHLORIDE	42	6	1	J	A	7	B		2.52	5		2	4.76
STYRENE	42	0	5	U	V	5	U	V	NA			NA	NA
TETRACHLOROETHENE	42	42	20		V	120	D		61.6	1	•	42	100
TOLUENE	42	1	2	J	A	2	J	A	2.49	1000		0	0
TOTAL XYLENES	42	0	5	U	V	5	U	V	NA	10000		0	0
TRICHLOROETHENE	42	42	18		V	150	D		70.98	5		42	100
VINYL ACETATE	39	0	10	U	V	10	U	V	NA			NA	NA
VINYL CHLORIDE	42	9	2	J	A	14	V		4.9	2	•	9	21.43
cis-1,3-DICHLOROPROPENE	41	0	5	U	V	5	U	V	NA			NA	NA
trans-1,3-DICHLOROPROPENE	41	0	5	U	V	5	U	V	NA			NA	NA

Notes:
-Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
-In calculating the mean, one-half the detection limit is used for non-detects; if the detection limit is greater than 2 times the CRQL, the data point is not used.
-Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit; B - Organics:present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off-scale in both columns
-Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

TABLE 5-3
SUMMARY OF SURFACE WATER CHARACTERIZATION
WITH SUMMARY STATISTICS FOR ANALYTES OF CONCERN
USING ALL AVAILABLE NON-REJECTED DATA
STATION NUMBER SW-061

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
Total Radiochemistry (pCi/l)												
AMERICIUM-241 (Total)	37	27	-.005 +/- .01	U	V	.1539 +/- .0377		A	0.0169	0.05	2	5.41
GROSS ALPHA (Total)	35	28	-.539 +/- .996	J		8.096 +/- 2.84			3.6578	11	0	0
GROSS BETA (Total)	37	35	2.038 +/- 1.45	J		16.42 +/- 2.73			5.0446	19	0	0
PLUTONIUM-239 (Total)	1	0	.005 +/- .007	U	A	.005 +/- .007	U	A	NA	0.05	0	0
PLUTONIUM-239/240 (Total)	38	28	-0.002 +/- 0.003	U	V	.2291 +/- .0393		A	0.0226	0.05	2	5.26
TOTAL URANIUM (Total)	35	35	0.433			2.69629			1.624	10	0	0
Total Metals (ug/l)												
ALUMINUM (Total)	48	41	27.2		V	5070		V	337.85	200	16	33.33
ARSENIC (Total)	46	4	.5	U	JA	1.4	B	V	0.8	50	0	0
BARIUM (Total)	48	48	58	B	V	188	B	V	156.07	1000	0	0
BERYLLIUM (Total)	48	4	.3	U	V	1.8		JA	0.41	100	0	0
CADMIUM (Total)	48	1	1	U	V	1.7		JA	1.29	5	0	0
CHROMIUM (Total)	48	9	2	U	V	8.3		JA	2.12	10	0	0
COPPER (Total)	45	12	1.9	U	JA	16.2	B	V	2.78	25	0	0
IRON (Total)	48	48	34.3		JA	4250		V	489.99	1000	3	6.25
LEAD (Total)	47	24	.7	U	V	16.6		JA	2.18	5	5	10.64
MANGANESE (Total)	48	48	3.2		JA	316		V	75.19	1000	0	0
MERCURY (Total)	48	4	.1	U	V	.22		JA	0.1	0.2	3	6.25
NICKEL (Total)	48	1	2.6	U	V	2.7		V	4.66	40	0	0
SELENIUM (Total)	48	13	.7	U	JA	3.4	W	JA	1.18	10	0	0
ZINC (Total)	48	48	29.5			333	E	JA	117.17	50	39	81.25
Filtered Metals (ug/l)												
IRON (Filtered)	47	30	6.2	U	JA	588		V	38.74	300	1	2.13
MANGANESE (Filtered)	48	48	2.8		JA	320		V	65.53	50	29	60.42
Volatile Organics (ug/l)												
1,1,1-TRICHLOROETHANE	48	21	1	J	A	9		Z	2.91	200	0	0
1,1,2,2-TETRACHLOROETHANE	49	0	5	U	V	5	U	V	NA		NA	NA
1,1,2-TRICHLOROETHANE	49	0	5	U	V	5	U	V	NA		NA	NA
1,1-DICHLOROETHANE	49	12	1	J	A	7		V	2.44		NA	NA
1,1-DICHLOROETHENE	48	0	5	U	V	5	U'	V	NA	7	0	0

Notes:
-Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
-In calculating the mean, one-half the detection limit is used for non-detects; If the detection limit is greater than 2 times the CRQL, the data point is not used.
-Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit; B - Organics:present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off-scale in both columns
-Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

TABLE 5-3 (Continued)
SUMMARY OF SURFACE WATER CHARACTERIZATION WITH SUMMARY STATISTICS FOR ANALYTES OF CONCERN USING ALL AVAILABLE NON-REJECTED DATA
STATION NUMBER SW-061

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR		No. ≥ ARAR	% ≥ ARAR
1,2-DICHLOROETHANE	48	1	1	J	A	1	J	A	2.47			NA	NA
1,2-DICHLOROETHENE	49	40	3	J	A	120		V	20.21			NA	NA
1,2-DICHLOROPROPANE	49	0	5	U	V	5	U	V	NA			NA	NA
2-BUTANONE	46	1	10	U	V	14		V	5.2			NA	NA
2-HEXANONE	47	1	10	U	V	12		V	5.15			NA	NA
4-METHYL-2-PENTANONE	48	1	10	U	V	11		V	5.13			NA	NA
ACETONE	45	4	3	J	A	44		JA	5.77			NA	NA
BENZENE	49	0	5	U	V	5	U	V	NA			NA	NA
BROMODICHLOROMETHANE	48	0	5	U	V	5	U	V	NA	100	U	0	0
BROMOFORM	48	0	5	U	V	5	U	V	NA			NA	NA
BROMOMETHANE	47	0	10	U	V	10	U	V	NA			NA	NA
CARBON DISULFIDE	48	0	5	U	V	5	U	V	NA			NA	NA
CARBON TETRACHLORIDE	47	32	1	J	A	14		V	5.2	5		20	42.55
CHLOROBENZENE	49	0	5	U	V	5	U	V	NA			NA	NA
CHLOROETHANE	49	0	10	U	V	10	U	V	NA			NA	NA
CHLOROFORM	49	9	.8	J	A	3	J	A	2.34	1	*	8	16.33
CHLOROMETHANE	48	0	10	U	V	10	U	V	NA			NA	NA
DIBROMOCHLOROMETHANE	48	0	5	U	V	5	U	V	NA			NA	NA
ETHYLBENZENE	49	0	5	U	V	5	U	V	NA			NA	NA
METHYLENE CHLORIDE	49	6	1	J	A	36	B	JA	3.04	5		2	4.08
STYRENE	49	0	5	U	V	5	U	V	NA			NA	NA
TETRACHLOROETHENE	49	28	1	J	A	22		V	4.79	1	*	28	57.14
TOLUENE	49	2	2	J	A	7		JA	2.58	1000		0	0
TOTAL XYLENES	49	1	2	J	A	2	J	A	2.49	10000		0	0
TRICHLOROETHENE	49	31	1	J		32		JA	5.45	5		16	32.65
VINYL ACETATE	47	0	10	U	V	10	U	V	NA			NA	NA
VINYL CHLORIDE	49	16	1	J	A	37		V	5.63	2	*	15	30.61
cis-1,3-DICHLOROPROPENE	48	0	5	U	V	5	U	V	NA			NA	NA
trans-1,3-DICHLOROPROPENE	47	0	5	U	V	5	U	V	NA			NA	NA

Notes:
- Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
- In calculating the mean, one-half the detection limit is used for non-detects; if the detection limit is greater than 2 times the CRQL, the data point is not used.
- Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit; B - Organics:present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off scale in both columns
- Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

TABLE 5-4
SUMMARY OF SURFACE WATER CHARACTERIZATION WITH SUMMARY STATISTICS FOR ANALYTES OF CONCERN USING ALL AVAILABLE NON-REJECTED DATA STATION NUMBER SW-132

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
Total Radiochemistry (pCi/l)												
AMERICIUM-241 (Total)	14	8	0 +/- 0.004	U		0.27 +/- 0.045			0.0325	0.05	2	14.29
GROSS ALPHA (Total)	14	14	2.4 +/- 1.6			5.3 +/- 1.8			3.7571	11	0	0
GROSS BETA (Total)	14	14	2.5 +/- 1.2	J		9.6 +/- 1.6			4.4643	19	0	0
PLUTONIUM-239/240 (Total)	14	7	0.002 +/- 0.009	U		0.045 +/- 0.013			0.0106	0.05	0	0
TOTAL URANIUM (Total)	14	14	0.28667			2.66000			1.9196	10	0	0
Total Metals (ug/l)												
ALUMINUM (Total)	13	12	15	U		2740		V	355.92	200	3	23.08
ARSENIC (Total)	14	14	1.4	B	V	4.7	B		2.39	50	0	0
BARIUM (Total)	14	14	46.2	B	V	129	B	V	108.23	1000	0	0
BERYLLIUM (Total)	14	0	1	U	V	1	U	V	NA	100	0	0
CADMIUM (Total)	14	0	4	U	V	4	U	V	NA	5	0	0
CHROMIUM (Total)	14	0	3	U	V	3	U	V	NA	10	0	0
COPPER (Total)	14	8	2	U	V	8.9	B	V	3.19	25	0	0
IRON (Total)	14	14	186			3700		V	698.57	1000	2	14.29
LEAD (Total)	14	4	1	U	V	7.2		V	1.26	5	1	7.14
MANGANESE (Total)	14	14	9.9	B	V	139		V	25.14	1000	0	0
MERCURY (Total)	14	0	0.2	U	V	0.2	U	V	NA	0.2	0	0
NICKEL (Total)	14	1	7	U	V	8.1	B		3.83	40	0	0
SELENIUM (Total)	14	13	1	UW	V	5.2		V	3.34	10	0	0
ZINC (Total)	14	14	31.4			194	E	JA	67.03	50	8	57.14
Filtered Metals (ug/l)												
IRON (Filtered)	13	7	7	UN	V	162			30.48	300	0	0
MANGANESE (Filtered)	14	14	5.4	B	V	20.6			11.28	50	0	0
Volatile Organics (ug/l)												
1,1,1-TRICHLOROETHANE	14	0	5	U		5	U		NA	200	0	0
1,1,2,2-TETRACHLOROETHANE	14	0	5	U		5	U		NA		NA	NA
1,1,2-TRICHLOROETHANE	14	0	5	U		5	U		NA		NA	NA
1,1-DICHLOROETHANE	14	0	5	U		5	U		NA		NA	NA
1,1-DICHLOROETHENE	14	0	5	U		5	U		NA	7	0	0
1,2-DICHLOROETHANE	14	0	5	U		5	U		NA		NA	NA

Notes:
- Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
- In calculating the mean, one-half the detection limit is used for non-detects; if the detection limit is greater than 2 times the CRQL, the data point is not used.
- Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit; B - Organics:present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off-scale in both columns
- Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

TABLE 5-4 (Continued)
SUMMARY OF SURFACE WATER CHARACTERIZATION
WITH SUMMARY STATISTICS FOR ANALYTES OF CONCERN
USING ALL AVAILABLE NON-REJECTED DATA
STATION NUMBER SW-132

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR		No. ≥ ARAR	% ≥ ARAR
Volatile Organics (ug/l) (Continued)													
1,2-DICHLOROETHENE	14	10	1	JX	A	5	X		2.57			NA	NA
1,2-DICHLOROPROPANE	14	0	5	U		5	U		NA			NA	NA
2-BUTANONE	14	0	10	U		10	U		NA			NA	NA
2-HEXANONE	14	0	10	U		10	U		NA			NA	NA
4-METHYL-2-PENTANONE	14	0	10	U		10	U		NA			NA	NA
ACETONE	14	0	10	U		10	U		NA			NA	NA
BENZENE	14	0	5	U		5	U		NA			NA	NA
BROMODICHLOROMETHANE	14	0	5	U		5	U		NA	100	U	0	0
BROMOFORM	14	0	5	U		5	U		NA			NA	NA
BROMOMETHANE	14	0	10	U		10	U		NA			NA	NA
CARBON DISULFIDE	14	0	5	U		5	U		NA			NA	NA
CARBON TETRACHLORIDE	14	0	5	U		5	U		NA	5		0	0
CHLOROBENZENE	14	0	5	U		5	U		NA			NA	NA
CHLOROETHANE	14	0	10	U		10	U		NA			NA	NA
CHLOROFORM	14	0	5	U		5	U		NA	1	*	0	0
CHLOROMETHANE	14	0	10	U		10	U		NA			NA	NA
DIBROMOCHLOROMETHANE	14	0	5	U		5	U		NA			NA	NA
ETHYLBENZENE	14	0	5	U		5	U		NA			NA	NA
METHYLENE CHLORIDE	14	0	5	U		5	U		NA	5		0	0
STYRENE	14	0	5	U		5	U		NA			NA	NA
TETRACHLOROETHENE	14	1	1	J	A	1	J	A	2.39	1	*	1	7.14
TOLUENE	14	0	5	U		5	U		NA	1000		0	0
TOTAL XYLENES	14	2	5	U		5	BJX	JA	2.86	10000		0	0
TRICHLOROETHENE	14	0	5	U		5	U		NA	5		0	0
VINYL ACETATE	14	0	10	U		10	U		NA			NA	NA
VINYL CHLORIDE	14	0	10	U		10	U		NA	2	*	0	0
cis-1,3-DICHLOROPROPENE	14	0	5	U		5	U		NA			NA	NA
trans-1,3-DICHLOROPROPENE	14	0	5	U		5	U		NA			NA	NA

Notes:
-Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
-In calculating the mean, one-half the detection limit is used for non-detects; if the detection limit is greater than 2 times the CRQL, the data point is not used.
-Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit; B - Organics:present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off scale in both columns
-Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

Dissolved Metals: Iron and manganese are the only dissolved metals with ARARs. Fourteen of 40 samples exhibited detectable concentrations of dissolved iron. The one sample that exceeded the ARAR of 300 $\mu g/\ell$ was also the maximum detected value of 1,550 $\mu g/\ell$. The mean dissolved iron concentration of 55.8 $\mu g/\ell$ does not exceed the ARAR. Twenty-five of 41 dissolved manganese samples exhibited detectable concentrations, with only 1 sample exceeding the ARAR of 50 $\mu g/\ell$. The mean value for dissolved manganese of 8.5 $\mu g/\ell$ does not exceed the ARAR.

Total Metals: Aluminum and zinc are the only two metals that were detected frequently (22 and 41 out of 41 samples, respectively) in concentrations exceeding their respective ARARs. Iron, lead, mercury, and chromium were detected in concentrations exceeding their respective ARAR values but considerably less frequently (5 or less out of 41) than aluminum and zinc. Mean values for all metals except aluminum and zinc do not exceed their respective ARARs.

5.2.3.2 Surface Water Station SW-61

Total Radionuclides: Americium-241 and plutonium-239/240 exceeded ARAR in only 2 of 37 and 2 of 38 samples, respectively. The remaining analytes were not detected in concentrations exceeding their respective ARARs. Mean concentrations for all analytes were below ARARs.

Volatile Organic Compounds: Carbon tetrachloride was detected in 32 of 47 samples and 20 of the 32 detections exhibited concentrations exceeding the ARAR. However, the maximum concentration was only 14 $\mu g/\ell$, and the mean concentration was only 5.2 $\mu g/\ell$ (ARAR = 5 $\mu g/\ell$). Chloroform was detected in 9 of 49 samples, and 8 of the 9 detections exhibited concentrations exceeding the ARAR. However, the maximum concentration was only 3 $\mu g/\ell$ and the mean concentration was only 2.3 $\mu g/\ell$ (ARAR = 1U $\mu g/\ell$). Also, the true mean concentration may be lower because one-half the detection limit of 5 $\mu g/\ell$ was used as a substitute value for non-detects. Tetrachloroethene was detected in 28 of 49 samples, and all 28 detections were at or above the ARAR of 1U $\mu g/\ell$. However, like chloroform, the maximum concentration was relatively low (22 $\mu g/\ell$) and the mean concentration may be biased high due to use of replacement values for non-detects (detection limit = 5 $\mu g/\ell$). Trichloroethene was detected in 31 of 49 samples, and 16 of the 31 detections exhibited concentrations exceeding the ARAR (5 $\mu g/\ell$). However, the maximum concentration was only 32 $\mu g/\ell$ and the mean concentration was approximately equal to the ARAR. Vinyl chloride was detected in 16 of 49 samples, and 15 of these detections exhibited concentrations at or above the ARAR. However, like chloroform and tetrachloroethene, the maximum value was relatively low (37 $\mu g/\ell$) and the mean concentration may be biased high due to use of replacement values for non-detects.

Summary statistics indicate that methylene chloride exhibited detectable concentrations in excess of the ARAR value; however, the mean value did not exceed ARAR. Methylene chloride was detected in 6 of 49 samples, and 2 of the 6 detections exceeded ARAR.

The remaining TCL VOCs with ARARs that were detected (1,1,1 trichloroethane, toluene, and total xylenes) were detected in concentrations that did not exceed ARARs.

Of the TCL VOCs that do not have ARARs, 1,1 dichloroethane (detected in 12 of 49 samples) and 1,2 dichloroethene (detected in 40 of 49 samples) were detected somewhat frequently while 1,2 dichloroethane (detected in 1 of 48), 2-butanone (detected in 1 of 46), 2-hexanone (detected in 1 of 47), 4-methyl-2-pentanone (detected in 1 of 48), and acetone (detected in 4 of 45) were infrequently detected. In all cases, mean concentrations were less than or equal to 20 $\mu g/\ell$.

Dissolved Metals: Thirty of 47 samples exhibited detectable concentrations of dissolved iron; however, only 1 sample exceeded the ARAR (300 $\mu g/\ell$) at 588 $\mu g/\ell$. The mean dissolved iron concentration of 38.7 $\mu g/\ell$ did not exceed the ARAR. Twenty-nine of 48 manganese samples exceeded the ARAR; however, the mean value for dissolved manganese of 65.5 $\mu g/\ell$ just exceeded the ARAR (50 $\mu g/\ell$).

Total Metals: Aluminum and zinc are the only two metals that were detected frequently in concentrations exceeding their respective ARARs (16 of 48, and 39 of 48 respectively). However, their mean concentrations are not dramatically elevated above their respective ARARs

[338 $\mu g/\ell$ (ARAR = 200U $\mu g/\ell$) and 117 $\mu g/\ell$ (ARAR = 50 $\mu g/\ell$), respectively]. Iron, lead, and mercury were infrequently detected in concentrations exceeding their respective ARARs, and their mean concentrations did not exceed ARARs.

5.2.3.3 Surface Water Station SW-132

Total Radionuclides: The ARAR for americium-241 was exceeded in 2 of 14 samples; however, the mean concentration for all samples does not exceed the ARAR. The remaining analytes were not detected in concentrations exceeding their respective ARARs.

Volatile Organic Compounds: Tetrachloroethene and total xylenes were the only VOCs with ARARs that were detected. Tetrachloroethene was detected in 1 of 14 samples at an estimated concentration of 1 $\mu g/\ell$ which is equivalent to the ARAR. Total xylenes were detected in 2 of 14 samples. The maximum concentration detected was 5 $\mu g/\ell$ which does not exceed the ARAR of 10,000 $\mu g/\ell$.

None of the remaining TCL VOCs were detected with the exception of 1,2 dichloroethene which was detected in 10 of 14 samples at a maximum concentration of 5 $\mu g/\ell$. This compound has not been assigned an ARAR value.

Dissolved Metals: Mean dissolved iron and manganese concentrations did not exceed ARARs.

Total Metals: Of the total metals, zinc concentrations most frequently exceeded ARAR (8 of 14 samples); however, the mean zinc concentration (67 $\mu g/\ell$) was near the ARAR of 50 $\mu g/\ell$. Aluminum next most frequently exceeded ARAR (3 of 13 samples); however, like zinc, the mean concentration (356 $\mu g/\ell$) was near the ARAR (200 $\mu g/\ell$). Of the remaining metals, only iron and lead were detected in concentrations that exceeded ARAR (2 of 14 and 1 of 14 samples, respectively); however, their mean concentrations did not exceed their respective ARARs.

5.3 SUMMARY OF COMPLIANCE WITH ARARS

Table 5-5 presents a summary of the analytes at each surface water station that were detected above the ARAR value at a frequency of 10 percent or greater. The 10% screening level was selected to focus on those analytes that exhibit more frequent detections in excess of ARARs. This table illustrates that the relative degree of contamination is highest at Station SW-59 and lowest at Station SW-132. More analytes exhibit concentrations exceeding ARARs at a frequency of greater than 10 percent at SW-59 than at the other stations. Also, mean concentrations at this station significantly exceed ARARs, particularly for the VOCs. On the contrary, station SW-61 does not exhibit radionuclide contamination in excess of ARARs, and VOCs and metals ARAR exceedances are low in magnitude with the mean concentrations near ARARs. Station SW-132 exhibits americium-241, aluminum, lead, and zinc in excess of ARARs, but does not exhibit >10% ARAR exceedance for VOCs. For those analytes exceeding ARARs, mean concentrations are below or near ARARs.

Table 5-5

Summary of Surface Water Analytes That Exhibit ARAR Exceedance at a Frequency >10%[a]

Station SW-59 (ARAR/MEAN)[b]	Station SW-61 (ARAR/MEAN)[b]	Station SW-132 (ARAR/MEAN)[b]
Americium-241 (0.05/0.0192)		Americium-241 (0.05/0.0325)
Plutonium 239/240 (0.05/0.022)		
1,1 Dichloroethene (7/4.76)		
Carbon Tetrachloride (5/110.76)	Carbon Tetrachloride (5/5.2)	
Chloroform (1/19.19)	Chloroform (1/2.34)	
Tetrachloroethene (1/61.6)	Tetrachloroethene (1/4.79)	
Trichloroethene (5/70.98)	Trichloroethene (5/5.45)	
Vinyl Chloride (2/4.9)	Vinyl Chloride (2/5.63)	
Aluminum (200/619.58)	Aluminum (200/327.85)	Aluminum (200/129.85)
Iron (1,000/507.69)		Iron (1000/698.57)
Lead (5/2.17)	Lead (5/2.18)	
Mercury (0.20/0.12)		
Zinc (50/232.39)	Zinc (50/117.17)	Zinc (50/67.03)
	Dissolved Manganese (50/65.53)	

[a] Summary based on all available non-rejected data.
[b] Radionuclide ARAR/MEAN values are in pCi/ℓ. Metal and VOC ARAR/MEAN values are in μg/ℓ.

Section 6

SECTION 6
DATA QUALITY

With few exceptions, data were collected in accordance with the QA/QC documents specified in Sections 3 and 5 for treatability study and surface water characterization, respectively. The QA/QC procedures assure the precision, accuracy, comparability, completeness, and representativeness of the data. The data presented in this report generally meet the DQOs for the treatability study program.

6.1 STATUS OF DATA VALIDATION

As mentioned in Section 3, data that have not yet been validated were used in the statistical computations and assessments out of necessity, i.e., to provide an adequate quantity of data for characterization of the surface water sources and assessment of the performance of the treatment units. However, rejected data have not been used in any statistical computations or assessments. Use of unvalidated data should not reduce the soundness of the conclusions drawn, because most of the data that have been validated are designated as either valid or acceptable.

Table 6-1 summarizes the data validation status for the analytical data presented in this treatability study report. This table provides, by analyte group, the percentage of validated data and the percentage of rejected data for those data evaluated. Overall, greater than 50% of the data has been validated. With the exception of radiochemistry, less than 5% of the data in any individual analyte group has been rejected. The high percent rejection (15.2% and 56.1% for process and surface water data, respectively) of the radiochemistry data does somewhat compromise attaining the data quality objectives proposed for the study, particularly since unvalidated data are used. However, as shown in Table 6-2, the radiochemistry summary results for surface water are similar regardless of whether just valid data or all data are used.

Table 6-1

Summary of Data Validation

Analyte Group	Process Data (includes sludges, water, and carbon from Phase II)	Surface Water Data (5/1/92-present)
Percent Validated		
Total Radiochemistry	44.6	68.5
Total Metals	59.8	74.3
Dissolved Metals	47.6	71.3
CLP Volatiles	100	67.3
EPA Method 524.2	12.8	0.0
Percent Rejected (of Validated Results)		
Total Radiochemistry	15.2	56.1
Total Metals	1.0	1.0
Dissolved Metals	1.2	1.8
CLP Volatiles	3.0	1.0
EPA Method 524.2	0.0	Not applicable

TABLE 6-2
COMPARISON OF RADIOCHEMISTRY RESULTS
VALIDATED DATA vs. ALL DATA*
(Activities reported in pCi/l)

SW059 Validated Data

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
AMERICIUM-241 (Total)	21	15	-.004 +/- .01	U	V	.12 +/- .024		A	0.0180	0.05	3	14.29
GROSS ALPHA (Total)	17	12	.133 +/- 1.96	J	A	21 +/- 2.5		A	5.2265	11	2	11.76
GROSS BETA (Total)	17	15	2.918 +/- 1.11	J	A	17 +/- 3.3		V	6.4527	19	0	0
PLUTONIUM-239 (Total)	1	1	.024 +/- .012		A	.024 +/- .012		A	0.0240	0.05	0	0
PLUTONIUM-239/240 (Total)	22	15	.001 +/- .01	U	V	.16 +/- .026		V	0.0243	0.05	2	9.09
TOTAL URANIUM (Total)	20	20	1.49633		A	2.93333		A	2.2472	10	.0	0

SW059 All Data

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
AMERICIUM-241 (Total)	27	18	-.004 +/- .01	U	V	.12 +/- .024		A	0.0192	0.05	4	14.81
GROSS ALPHA (Total)	29	22	-.264 +/- 1.28	J		21 +/- 2.5		A	4.5236	11	2	6.90
GROSS BETA (Total)	29	24	1.3 +/- 1.2	U		17 +/- 3.3		V	5.1610	19	0	0
PLUTONIUM-239 (Total)	1	1	.024 +/- .012		A	.024 +/- .012		A	0.0240	0.05	0	0
PLUTONIUM-239/240 (Total)	29	19	0 +/- 0.004	U		.16 +/- .026		V	0.0223	0.05	3	10.34
TOTAL URANIUM (Total)	27	27	1.49633		A	2.93333		A	2.2052	10	0	0

SW061 Validated Data

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
AMERICIUM-241 (Total)	30	23	-.005 +/- .01	U	V	.1539 +/- .0377		A	0.0160	0.05	1	3.33
GROSS ALPHA (Total)	23	17	1.7 +/- 3	U	A	7.422 +/- 2.81		V	3.8986	11	0	0
GROSS BETA (Total)	25	24	2.9 +/- 0.91	J	A	11 +/- 1.3		A	5.2957	19	0	0
PLUTONIUM-239 (Total)	1	0	.005 +/- .007	U	A	.005 +/- .007	U	A	NA	0.05	0	0
PLUTONIUM-239/240 (Total)	31	24	-0.002 +/- 0.003	U	V	.2291 +/- .0393		A	0.0204	0.05	1	3.23
TOTAL URANIUM (Total)	28	28	0.43300		A	2.68737		A	1.5767	10	0	0

SW061 All Data

Analyte	No. of Samples	No. of Detects	Minimum			Maximum			Mean	ARAR	No. ≥ ARAR	% ≥ ARAR
AMERICIUM-241 (Total)	37	27	-.005 +/- .01	U	V	.1539 +/- .0377		A	0.0169	0.05	2	5.41
GROSS ALPHA (Total)	35	28	-.539 +/- .996	J		8.096 +/- 2.84			3.6578	11	0	0
GROSS BETA (Total)	37	35	2.038 +/- 1.45	J		16.42 +/- 2.73			5.0446	19	0	0
PLUTONIUM-239 (Total)	1	0	.005 +/- .007	U	A	.005 +/- .007	U	A	NA	0.05	0	0
PLUTONIUM-239/240 (Total)	38	28	-0.002 +/- 0.003	U	V	.2291 +/- .0393		A	0.0226	0.05	2	5.26
TOTAL URANIUM (Total)	35	35	0.43300		A	2.69629			1.6240	10	0	0

Notes:
- Format for minimum and maximum values: result (with counting error for Radiochemistry) followed by qualifier and validation code.
- In calculating the mean, one-half the detection limit is used for non detects; If the detection limit is greater than 2 times the CRQL, the data point is not used.
- Data Qualifiers: U-Compound/Analyte not found at or above the detection limit; J - estimated below the detection limit, B - Organics present in blank; Inorganics - present below detection limit; E - Estimated (high concentration); X - Estimated due to confirmed compound off scale in both columns
- Validation Codes: V - Valid; A - Acceptable with qualifications; JA - Acceptable, estimated value; R - Rejected

* Rejected data has not been included in this table. Radiochemistry data for SW132 has not yet been validated.

6.2 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY & COMPLETENESS (PARCC PARAMETERS)

6.2.1 Precision

The data from a sample and duplicate sample provide a measure of the sampling/analytical precision and sample homogeneity, i.e., the amount of error in the data attributed to sampling/analytical technique, or to variability in the analyte concentration in the medium being sampled. Precision is measured by calculating the Relative Percent Difference (RPD), i.e., the difference between the field sample and duplicate concentration divided by their average, expressed as a percent.

6.2.1.1 Field Precision

The field precision objective specified in the QAA is to obtain a RPD of ≤ 30% for aqueous samples. Field duplicates were not collected for the treatability study, and therefore, field precision cannot be assessed. However, the general consistency of the data over time at a given station do not indicate precision problems associated with the sampling technique.

With respect to surface water characterization, field duplicates are taken at a frequency of 10%. Because sampling at SW-59, SW-61, and SW-132 is part of the site-wide program, it would be necessary to tally the number of duplicates for the entire site-wide program to determine if the 10% frequency goal was met. This is beyond the scope of this study. However, review of the RFEDs output for the three surface water stations in South Walnut Creek showed that one duplicate was collected that actually corresponded to a sample collected from one of the three South Walnut Creek stations. A summary of the degree to which the field precision goals were met based on this field duplicate is provided in Table 6-3. As can be seen in this table, only rarely did the RPD exceed 30%.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Volatile Organics Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
ETHYLBENZENE												
SW061	10/17/91	SW01687WC, SW80165WC	ETHYLBENZENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
STYRENE												
SW061	10/17/91	SW01687WC, SW80165WC	STYRENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CIS-1,3-DICHLOROPROPENE												
SW061	10/17/91	SW01687WC, SW80165WC	cis-1,3-DICHLOROPROPENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TRANS-1,3-DICHLOROPROPENE												
SW061	10/17/91	SW01687WC, SW80165WC	trans-1,3-DICHLOROPROPENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria; 0.000				
1,2-DICHLOROETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	1,2-DICHLOROETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
VINYL ACETATE												
SW061	10/17/91	SW01687WC, SW80165WC	VINYL ACETATE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
4-METHYL-2-PENTANONE												
SW061	10/17/91	SW01687WC, SW80165WC	4-METHYL-2-PENTANONE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TOLUENE												
SW061	10/17/91	SW01687WC, SW80165WC	TOLUENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CHLOROBENZENE												
SW061	10/17/91	SW01687WC, SW80165WC	CHLOROBENZENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
DIBROMOCHLOROMETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	DIBROMOCHLOROMETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TETRACHLOROETHENE												
SW061	10/17/91	SW01687WC, SW80165WC	TETRACHLOROETHENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TOTAL XYLENES												

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

page 1

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Volatile Organics Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
SW061	10/17/91	SW01687WC, SW80165WC	TOTAL XYLENES	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,2-DICHLOROETHENE												
SW061	10/17/91	SW01687WC, SW80165WC	1,2-DICHLOROETHENE	8		UG/L	V	7		UG/L	V	13.33
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CARBON TETRACHLORIDE												
SW061	10/17/91	SW01687WC, SW80165WC	CARBON TETRACHLORIDE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
2-HEXANONE												
SW061	10/17/91	SW01687WC, SW80165WC	2-HEXANONE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
ACETONE												
SW061	10/17/91	SW01687WC, SW80165WC	ACETONE	47	U	UG/L	JA	10	U	UG/L	JA	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CHLOROFORM												
SW061	10/17/91	SW01687WC, SW80165WC	CHLOROFORM	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BENZENE												
SW061	10/17/91	SW01687WC, SW80165WC	BENZENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,1,1-TRICHLOROETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	1,1,1-TRICHLOROETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BROMOMETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	BROMOMETHANE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CHLOROMETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	CHLOROMETHANE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CHLOROETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	CHLOROETHANE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
VINYL CHLORIDE												
SW061	10/17/91	SW01687WC, SW80165WC	VINYL CHLORIDE	10	U	UG/L	V	10	U	UG/L	V	0.00

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Volatile Organics Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
METHYLENE CHLORIDE												
SW061	10/17/91	SW01687WC, SW80165WC	METHYLENE CHLORIDE	13	U	UG/L	JA	5	U	UG/L	JA	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CARBON DISULFIDE												
SW061	10/17/91	SW01687WC, SW80165WC	CARBON DISULFIDE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BROMOFORM												
SW061	10/17/91	SW01687WC, SW80165WC	BROMOFORM	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BROMODICHLOROMETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	BROMODICHLOROMETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,1-DICHLOROETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	1,1-DICHLOROETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,1-DICHLOROETHENE												
SW061	10/17/91	SW01687WC, SW80165WC	1,1-DICHLOROETHENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,2-DICHLOROPROPANE												
SW061	10/17/91	SW01687WC, SW80165WC	1,2-DICHLOROPROPANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
2-BUTANONE												
SW061	10/17/91	SW01687WC, SW80165WC	2-BUTANONE	10	U	UG/L	V	10	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,1,2-TRICHLOROETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	1,1,2-TRICHLOROETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TRICHLOROETHENE												
SW061	10/17/91	SW01687WC, SW80165WC	TRICHLOROETHENE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
1,1,2,2-TETRACHLOROETHANE												
SW061	10/17/91	SW01687WC, SW80165WC	1,1,2,2-TETRACHLOROETHANE	5	U	UG/L	V	5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Filtered Metals Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
ALUMINUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	ALUMINUM (Filtered)	22.3	U	UG/L	V	22.3	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
IRON (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	IRON (Filtered)	16.7	U	UG/L	V	16.7	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
LEAD (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	LEAD (Filtered)	9		UG/L	JA	.9	U	UG/L	JA	163.64
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
LITHIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	LITHIUM (Filtered)	10.6		UG/L	V	9.1		UG/L	V	15.23
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MAGNESIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	MAGNESIUM (Filtered)	14200		UG/L	V	13700		UG/L	V	3.58
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MANGANESE (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	MANGANESE (Filtered)	37.5		UG/L	V	34.1		UG/L	V	9.50
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MERCURY (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	MERCURY (Filtered)	.2	U	UG/L	V	.2	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MOLYBDENUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	MOLYBDENUM (Filtered)	5.8	U	UG/L	V	5.8	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
NICKEL (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	NICKEL (Filtered)	5.9	U	UG/L	V	5.9	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
POTASSIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	POTASSIUM (Filtered)	1220		UG/L	JA	1250		UG/L	JA	2.43
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
SILICON (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	SILICON (Filtered)	5070		UG/L	V	5060		UG/L	JA	0.20
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
SILVER (FILTERED)												

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean OU2 Surface Water Filtered Metals Field Duplicates Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
SW061	10/17/91	SW01687WC, SW80165WC	SILVER (Filtered)	5.6		UG/L	JA	4.7		UG/L	JA	17.48
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
SODIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	SODIUM (Filtered)	32800		UG/L	V	33100		UG/L	V	0.91
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
STRONTIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	STRONTIUM (Filtered)	416		UG/L	V	401		UG/L	V	3.67
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
THALLIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	THALLIUM (Filtered)	1.9	U	UG/L	V	1.9	U	UG/L	JA	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TIN (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	TIN (Filtered)	10.4	U	UG/L	V	10.4	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
ANTIMONY (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	ANTIMONY (Filtered)	13.8	U	UG/L	V	13.8	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
ARSENIC (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	ARSENIC (Filtered)	1.1	U	UG/L	V	1.1	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BARIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	BARIUM (Filtered)	145		UG/L	V	140		UG/L	V	3.51
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BERYLLIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	BERYLLIUM (Filtered)	.5	U	UG/L	V	.5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CADMIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	CADMIUM (Filtered)	2.4	U	UG/L	V	2.4	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CESIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	CESIUM (Filtered)	500	U	UG/L	V	500	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CHROMIUM (FILTERED)												
SW061	10/17/91	SW01687WC, SW80165WC	CHROMIUM (Filtered)	2.6	U	UG/L	V	2.6	U	UG/L	V	0.00

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Filtered Metals Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result	Duplicate Result	Rel. % Diff.
			Number exceeding RPD criteria per number of duplicate pairs: 0/1		Percent exceeding criteria: 0.000	
COBALT (FILTERED)						
SW061	10/17/91	SW01687WC, SW80165WC	COBALT (Filtered)	2.8 U UG/L V	2.8 U UG/L V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1		Percent exceeding criteria: 0.000	
COPPER (FILTERED)						
SW061	10/17/91	SW01687WC, SW80165WC	COPPER (Filtered)	3.3 UG/L V	2.1 U UG/L V	44.44
			Number exceeding RPD criteria per number of duplicate pairs: 1/1		Percent exceeding criteria: 100.000	
VANADIUM (FILTERED)						
SW061	10/17/91	SW01687WC, SW80165WC	VANADIUM (Filtered)	2.3 U UG/L V	2.3 UG/L JA	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1		Percent exceeding criteria: 0.000	
ZINC (FILTERED)						
SW061	10/17/91	SW01687WC, SW80165WC	ZINC (Filtered)	4.3 U UG/L V	4.3 U UG/L V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1		Percent exceeding criteria: 0.000	
CALCIUM (FILTERED)						
SW061	10/17/91	SW01687WC, SW80165WC	CALCIUM (Filtered)	74800 UG/L V	72500 UG/L V	3.12
			Number exceeding RPD criteria per number of duplicate pairs: 0/1		Percent exceeding criteria: 0.000	
SELENIUM (FILTERED)						
SW061	10/17/91	SW01687WC, SW80165WC	SELENIUM (Filtered)	1.5 U UG/L V	1.5 U UG/L V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1		Percent exceeding criteria: 0.000	

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Total Metals Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
ALUMINUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	ALUMINUM (Total)	88.6		UG/L		150		UG/L	V	51.47
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
IRON (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	IRON (Total)	258		UG/L	V	283		UG/L	V	9.24
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
LEAD (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	LEAD (Total)	5.8		UG/L	V	4.1		UG/L	V	34.34
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
LITHIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	LITHIUM (Total)	7.1	U	UG/L	V	9.9		UG/L	V	32.94
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
MAGNESIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	MAGNESIUM (Total)	14200		UG/L	V	14500		UG/L	V	2.09
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MANGANESE (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	MANGANESE (Total)	47		UG/L	V	45.9		UG/L	V	2.37
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MERCURY (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	MERCURY (Total)	.2	U	UG/L	V	.2	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
MOLYBDENUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	MOLYBDENUM (Total)	5.8	U	UG/L	V	5.8	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
NICKEL (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	NICKEL (Total)	5.9	U	UG/L	V	5.9	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
POTASSIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	POTASSIUM (Total)	1230		UG/L	V	1880		UG/L	V	41.80
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
SILICON (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	SILICON (Total)	5540		UG/L	V	5900		UG/L	V	6.29
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
SILVER (TOTAL)												

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Total Metals Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
SW061	10/17/91	SW01687WC, SW80165WC	SILVER (Total)	2.9	U	UG/L	V	2.9	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
SODIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	SODIUM (Total)	31000		UG/L	V	31600		UG/L	V	1.92
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
STRONTIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	STRONTIUM (Total)	420		UG/L	V	423		UG/L	V	0.71
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
THALLIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	THALLIUM (Total)	1.9	U	UG/L	V	1.9	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TIN (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	TIN (Total)	10.4	U	UG/L	V	10.4	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
ANTIMONY (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	ANTIMONY (Total)	13.8	U	UG/L	V	13.8	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
ARSENIC (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	ARSENIC (Total)	1.1	U	UG/L	V	1.1	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BARIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	BARIUM (Total)	153		UG/L	V	156		UG/L	V	1.94
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
BERYLLIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	BERYLLIUM (Total)	.5	U	UG/L	V	.5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CADMIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	CADMIUM (Total)	2.4	U	UG/L	JA	2.4	U	UG/L	JA	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CESIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	CESIUM (Total)	500	U	UG/L	V	500	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CHROMIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	CHROMIUM (Total)	2.6	U	UG/L	V	2.6	U	UG/L	V	0.00

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Total Metals Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
COBALT (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	COBALT (Total)	2.8	U	UG/L	V	2.8	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
COPPER (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	COPPER (Total)	2.5		UG/L		3.2		UG/L		24.56
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
VANADIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	VANADIUM (Total)	2.3	U	UG/L	V	2.3	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
ZINC (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	ZINC (Total)	52.6		UG/L	V	57.1		UG/L	V	8.20
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CALCIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	CALCIUM (Total)	74200		UG/L	V	77100		UG/L	V	3.83
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
SELENIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	SELENIUM (Total)	1.5	U	UG/L	V	1.5	U	UG/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

Table 6-3

Relative Percent Difference from the Mean
OU2 Surface Water Total Radiochemistry Field Duplicates
Stations SW059, SW061, SW132

Location	Date	Sample, Duplicate ID	Analyte	Sample Result				Duplicate Result				Rel. % Diff.
PLUTONIUM-239/240 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	PLUTONIUM-239/240 (Total)	.007	J	PCI/L	A	.005	J	PCI/L	A	33.33
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
GROSS BETA (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	GROSS BETA (Total)	4.5		PCI/L	A	4.5		PCI/L	A	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
TRITIUM (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	TRITIUM (Total)	73	U	PCI/L	V	280	U	PCI/L	V	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
CESIUM-137 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	CESIUM-137 (Total)	1.2		PCI/L	A	.23	U	PCI/L	A	135.66
			Number exceeding RPD criteria per number of duplicate pairs: 1/1					Percent exceeding criteria: 100.000				
URANIUM-233,-234 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	URANIUM-233,-234 (Total)	2.3	B	PCI/L	A	2	B	PCI/L	A	13.95
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
STRONTIUM-89,90 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	STRONTIUM-89,90 (Total)	.25	J	PCI/L	A	.25	U	PCI/L	A	0.00
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
AMERICIUM-241 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	AMERICIUM-241 (Total)	.008	J	PCI/L	A	.007	J	PCI/L	A	13.33
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
URANIUM-235 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	URANIUM-235 (Total)	.07	J	PCI/L	A	.063	J	PCI/L	A	10.53
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				
URANIUM-238 (TOTAL)												
SW061	10/17/91	SW01687WC, SW80165WC	URANIUM-238 (Total)	1.6		PCI/L	A	1.7		PCI/L	A	6.06
			Number exceeding RPD criteria per number of duplicate pairs: 0/1					Percent exceeding criteria: 0.000				

Note: Where both Field Sample and Field Duplicate results are non-detects, RPD defaults to zero; Criteria: Soil - 40%, Water - 30%
Where one result is non-detect and one is detect, detection limit for non-detect is used to calculate RPD.

6.2.1.2 Laboratory Precision

Laboratory precision is evaluated through the use of laboratory duplicates for inorganic analyses and matrix spikes (MS) and matrix spike duplicates (MSD) for the organic analyses. Duplicate precision is calculated as RPD; MS/MSD precision is assessed by calculating a RPD between the percent recoveries (%R) observed for the method-specific spiked compounds. Laboratory precision goals are mandated by the analytical method for each analyte group and assessed for achievement during data validation. Data not meeting the precision goals are normally rejected.

With the exception of radiochemistry data, review of the validation summary presented in Table 6-1 indicates that data were rarely rejected. Therefore, laboratory precision goals were met. Typically radiochemical data were rejected for accuracy problems but occasionally these data were rejected due to precision related problems, e.g., replicate analysis not being performed, replicate precision criteria not being met, Laboratory Control Sample (LCS) relative percent error criteria not met, etc.

6.2.2 Accuracy

The accuracy of data obtained in an investigation is a function of the sampling technique, potential for sample contamination, and analytical capabilities of the laboratory. Accuracy means the nearness of a result, or the mean of a set of results, to the true value. Accuracy is assessed by analysis of reference samples of known concentration (i.e., LCS), by review of percent recoveries for spiked samples, and by review of blank data which may have an affect on measurement accuracy.

6.2.2.1 Field Accuracy

Field accuracy is assessed by comparing sample analyte concentrations to those present in associated field blanks. Field blanks are collected to quantify the analyte concentration in a sample that may be attributable to sampling procedures. This was not performed for the treatability study, and therefore assessing sample contamination arising from the sample bottle or determining the degree of cross-contamination of samples due to faulty decontamination procedures cannot be evaluated. However, the data do not suggest that laboratory or cross-contamination of samples is a problem, i.e., there are few outliers and data trends appear reasonable. Nevertheless, it is noted that collection of field QC samples has now been implemented.

With respect to surface water characterization, field blanks are taken with a 10% frequency. However, as with field duplicates, only one field blank was collected that directly correlates to a surface water sample collected from SW-59, SW-61, or SW-132. As shown in Table 6-4, the field blank data for this sample indicate that the sampling equipment are not significant sources contributing to the observed analyte concentrations in the field samples. This is concluded because of the absence or low concentrations of analytes in the blank relative to the samples.

6.2.2.2 Laboratory Accuracy

Accuracy of the chemical laboratory data is assessed through the calculation of %R from MS samples for inorganic analytes, MS/MSD samples for organic analytes, and any in-house or blind certified standards (i.e., LCS) that the laboratory analyzes as part of its ongoing QA/QC program. Acceptable recovery for the inorganic MS samples is routinely 75 to 125%. The %R for the organic MS/MSD analyses is mandated by the analytical method for the specific spiked compounds. Acceptable accuracy of the LCS is %R between 80 to 120%. Use of method blank analyses in the laboratory also assists in assessing the analytical accuracy. All of these measures of analytical accuracy are evaluated during the method data validation process. When analytical accuracy goals are not achieved, data are normally rejected.

With the exception of radiochemistry data, review of the validation summary presented in Table 6-1 indicates that data were rarely rejected, and, therefore, the accuracy of the data was acceptable. Radiochemistry data were often rejected because calibration verification criteria were not met, LCS recovery criteria were not met, or LCS data were not submitted, etc.

Table 6-4
Volatile Organic QC Blank Data - SW059, SW061, SW132

Location	Date	Sample	Analyte, Compound, Isotope	Result, error, qualifier, unit			Val Code	Analytical Group
SW SW061	10/17/91	SW80164WC	ETHYLBENZENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	STYRENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	cis-1,3-DICHLOROPROPENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	trans-1,3-DICHLOROPROPENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,2-DICHLOROETHANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	VINYL ACETATE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	4-METHYL-2-PENTANONE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	TOLUENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	CHLOROBENZENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	DIBROMOCHLOROMETHANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	TETRACHLOROETHENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	TOTAL XYLENES	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,2-DICHLOROETHENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	CARBON TETRACHLORIDE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	2-HEXANONE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	ACETONE	12	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	CHLOROFORM	5	U	UG/L	JA	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	BENZENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,1,1-TRICHLOROETHANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	BROMOMETHANE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	CHLOROMETHANE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	CHLOROETHANE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	VINYL CHLORIDE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	METHYLENE CHLORIDE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	CARBON DISULFIDE	5	U	UG/L	JA	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	BROMOFORM	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	BROMODICHLOROMETHANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,1-DICHLOROETHANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,1-DICHLOROETHENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,2-DICHLOROPROPANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	2-BUTANONE	10	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,1,2-TRICHLOROETHANE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	TRICHLOROETHENE	5	U	UG/L	V	VOCCLPTCL
SW SW061	10/17/91	SW80164WC	1,1,2,2-TETRACHLOROETHANE	5	U	UG/L	V	VOCCLPTCL

Qualifiers: U - Analyzed but not detected. B - Organics: present in blank; Inorganics: Reported value < CRDL and > IDL; J - Estimated value
Validation Codes: V - Valid; A - Acceptable with Qualifications; J - Estimated Value (usually associated with code "A"); R - Rejected

Table 6-4
Total Metal QC Blank Data - SW059, SW061, SW132

Location	Date	Sample	Analyte, Compound, Isotope	Result, error, qualifier, unit			Val Code	Analytical Group
SW SW061	10/17/91	SW80164WC	ALUMINUM	22.6		UG/L		SMETCLPTCL
SW SW061	10/17/91	SW80164WC	IRON	25.7		UG/L		SMETCLPTCL
SW SW061	10/17/91	SW80164WC	LEAD	5.1		UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	LITHIUM	7.1	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	MAGNESIUM	33.1	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	MANGANESE	2.6		UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	MERCURY	.2	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	MOLYBDENUM	5.8	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	NICKEL	5.9	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	POTASSIUM	675	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	SILICON	236		UG/L		SMETCLPTCL
SW SW061	10/17/91	SW80164WC	SILVER	2.9	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	SODIUM	435		UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	STRONTIUM	2.3	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	THALLIUM	1.9	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	TIN	10.4	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	ANTIMONY	13.8	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	ARSENIC	1.1	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	BARIUM	5.6	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	BERYLLIUM	.5	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	CADMIUM	2.4	U	UG/L	JA	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	CESIUM	500	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	CHROMIUM	2.6	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	COBALT	2.8	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	COPPER	2.3		UG/L		SMETCLPTCL
SW SW061	10/17/91	SW80164WC	VANADIUM	2.3	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	ZINC	4.3	U	UG/L	V	SMETCLPTCL
SW SW061	10/17/91	SW80164WC	CALCIUM	317		UG/L		SMETCLPTCL
SW SW061	10/17/91	SW80164WC	SELENIUM	1.5	U	UG/L	V	SMETCLPTCL

Qualifiers: U - Analyzed but not detected. B - Organics: present in blank; Inorganics: Reported value < CRDL and > IDL; J - Estimated value
Validation Codes: V - Valid; A - Acceptable with Qualifications; J - Estimated Value (usually associated with code "A"); R - Rejected

Table 6-4
Total Radiochemistry QC Blank Data - SW059, SW061, SW132

Location	Date	Sample	Analyte, Compound, Isotope	Result	error	qualifier	unit	Val Code	Analytical Group
SW SW061	10/17/91	SW80164WC	PLUTONIUM-239/240	.002	.002	J	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	GROSS ALPHA - DISSOLVED	.07	.26	U	PCI/L	R	TRADS
SW SW061	10/17/91	SW80164WC	GROSS BETA - DISSOLVED	.67	1.6	U	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	TRITIUM	-86	190	U	PCI/L	V	TRADS
SW SW061	10/17/91	SW80164WC	CESIUM-137	.69	.4	J	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	URANIUM-233,-234	.093	.12	BJ	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	STRONTIUM-89,90	.18	.14	U	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	AMERICIUM-241	.009	.01	J	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	URANIUM-235	0	.29	U	PCI/L	A	TRADS
SW SW061	10/17/91	SW80164WC	URANIUM-238	.068	.096	BJ	PCI/L	A	TRADS

Qualifiers: U - Analyzed but not detected. B - Organics: present in blank; Inorganics: Reported value < CRDL and > IDL; J - Estimated value
Validation Codes: V - Valid; A - Acceptable with Qualifications; J - Estimated Value (usually associated with code "A"); R - Rejected

6.2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with proper network design, sampling locations, and the sampling methods. The thoroughness of the sampling/analytical program presented in the approved and then implemented FSP ensures that the data are representative.

6.2.4 Comparability

Comparability is used to express the confidence with which one set of data can be compared to another set. Comparability is promoted by using similar sampling and analytical methods and reporting data in uniform units. To achieve comparability of data, all analyses prescribed in the FSP and performed in support of the treatability study and surface water characterization are EPA-accepted or equivalent methods. Comparability of the data supporting the treatability study and surface water characterization has also been promoted by using approved and standardized sampling techniques. The data are reported in uniform units: $\mu g/\ell$, micrograms per kilogram ($\mu g/kg$), picoCuries per liter (pCi/ℓ), and picoCuries per gram (pCi/g).

6.2.5 Completeness

The objective for completeness is that the study provides enough planned data so that the objectives of the project are met. Completeness for the treatability study and surface water characterization is evaluated by comparing the planned to the actual number of samples collected and analyzed. The analytical results should be validated and deemed valid or acceptable to be considered in an assessment of completeness. The overall completeness goal for the project is 90%.

Table 6-5 presents a completeness summary for the treatability study sampling and analysis. The table summarizes the number of planned samples and chemical analyses and the number of actual samples and chemical analyses. The actual number of chemical analyses include both unvalidated and validated data but exclude rejected data. As shown in Table 6-5 the sampling and analytical completeness were 61% and 50%, respectively. Although these results are low relative to the goal of 90%, the duration of the Phase II treatability study (10 months) was dictated by the Inter-Agency Agreement (IAG) and was not defined in the FSP, i.e., the duration appears to be conservative for an evaluation of the effectiveness of the FTU. Examination of the quantity of data collected at each process station indicates there is sufficient data to meet the objectives of the treatability study. However, as shown in Table 6-5, it will be necessary to collect chemical data on spent GAC (RS9) in order to properly manage the regeneration/disposal of this material.

Table 6-6 presents a similar completeness summary for Phase II surface water sources characterization sampling and analyses. The overall analytical completeness for the surface water characterization was 71%. Note that sampling completeness for VOCs, metals, and radionuclides for stations SW-59 and SW-61 exceeded the project goal of 90%, and in some cases exceeded 100%. Analytical completeness for VOCs and metals for stations SW-59 and SW-61 also exceeded the project goal. Analytical completeness for radionuclides was below expectations because, although samples were collected as planned, not all samples were analyzed for the complete list of radionuclides, and a higher rejection rate for radiochemistry analyses was realized. However, analytical completeness for the radionuclides with ARARs as indicated in the Basis for Design (Table 1-1) is approximately 70%. As explained in Section 5.1, data from station SW-132 were deemed unusable due to sampling problems which results in a 0% sampling and analytical completeness for this station during the Phase II reporting period (May 1992 through February 1993). However, useable data do exist for a 2-week period in September 1993. These data are included in the report.

Table 6-5

Completeness Summary for Phase II Treatability Study Sampling and Analyses

Chemical Class	Sampling Completeness[1]																							
	RS1			RS2			RS5			RS6			RS7			RS8			RS9			Totals		
	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C
VOCs	41	31	76	0	0	N/A	41	30	73	41	0	0	41	29	71	31	19	61	8	0	0	203	109	54
Total Metals	41	30	73	10	12	120	41	31	76	0	0	N/A	41	31	76	31	18	58	8	0	0	172	122	71
Dissolved Metals	41	24	59	10	2	20	41	23	56	0	0	N/A	41	23	56	0	0	N/A	8	0	0	141	72	51
Total Radionuclides	41	33	81	10	15	150	41	26	63	0	0	N/A	41	28	68	31	15	48	8	1	13	172	118	69
Totals	164	118	72	30	29	97	164	110	67	41	0	0	164	111	68	93	52	56	32	1	3	688	421	61

[1] No samples were planned for Stations RS3 or RS4.
A = Actual Number of Samples Collected
N/A = Not Applicable
P = Planned Number of Samples
%C = % Complete

Chemical Class	Analytical Completeness[2]																							
	RS1			RS2			RS5			RS6			RS7			RS8			RS9			Totals		
	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C	P	A	%C
VOCs	1394	1054	76	0	0	N/A	1394	490	35	1394	0	0	1394	986	71	1054	240	22	272	0	0	6902	2270	40
Total Metals	1189	865	73	290	345	119	1189	899	76	0	0	N/A	1189	866	73	899	200	22	232	0	0	4988	3175	64
Dissolved Metals	1189	696	59	290	230	79	1189	667	56	0	0	N/A	1189	635	53	0	0	N/A	232	0	0	4089	2228	55
Total Radionuclides	656	242	37	160	116	73	656	416	63	0	0	N/A	656	202	31	496	120	24	128	26	20	2752	1122	41
Totals	4428	2857	65	740	691	93	4428	2472	56	1394	0	0	4428	2689	61	2449	560	23	864	26	3	18731	9295	50

[2] No samples were planned for Stations RS3 or RS4.
A = Actual Number of Analytes Collected
N/A = Not Applicable
P = Planned Number of Analytes
%C = % Complete

Table 6-6

Completeness Summary for Phase II Surface Water Sources Characterization Sampling and Analyses

Chemical Class	Sampling Completeness											
	SW-59			SW-61			SW-132			Totals		
	P[a]	A	%C	P[a]	A	%C	P[a]	A	%C	P[a]	A	%C
VOCs	17	18	106	17	23	135	17	0	0	51	41	80
Total Metals	17	17	100	17	23	135	17	0	0	51	40	78
Dissolved Metals	17	17	100	17	23	135	17	0	0	51	40	78
Radionuclides	17	16	94	17	23	135	17	0	0	51	39	76
Totals	68	68	100	68	92	135	68	0	0	204	160	78

[a] The number of planned samples is based on monthly sampling during May, June, and July 1992 and semi-monthly sampling from August 1992 through February 1993.

P = Planned samples
A = Actual samples collected
%C = Percent complete

Chemical Class	Analytical Completeness											
	SW-59			SW-61			SW-132			Totals		
	P[b]	A[c]	%C	P[b]	A[c]	%C	P[b]	A[c]	%C	P[b]	A[c]	%C
VOCs	578	569	98	578	772	134	578	0	0	1734	1341	77
Total Metals	493	486	99	493	659	134	493	0	0	1479	1145	77
Dissolved Metals	493	485	98	493	657	133	493	0	0	1479	1142	77
Radionuclides	272	103	38	272	154	57	272	0	0	816	257	32
Totals	1836	1643	89	1836	2242	122	1836	0	0	5508	3885	71

[b] The number of planned analyses was determined by multiplying the number of planned samples by the number of analytes for each chemical class. The number of analytes for VOCs, total metals, dissolved metals, and radionuclides are 34, 29, 29, and 16, respectively.
[c] The actual number of analyses is the planned number of analyses less rejected data.

P = Planned analyses
A = Actual analyses
%C = Percent complete

Section 7

SECTION 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

7.1.1 FTU Effectiveness and Cost

The FTU was generally effective in reducing influent analyte concentrations. Influent analyte concentrations were often below ARARs. Even though these concentrations were low, comparison to effluent analyte concentrations showed a small but measurable net reduction in concentration. Influent concentrations were generally too low to accurately evaluate the system's effectiveness in treating higher analyte levels. When analyte concentrations were above ARARs, the system lowered the concentrations to below ARARs with only rare occasions of an effluent analyte concentration above ARAR.

Analyte losses occurred upstream of those units designed to treat specific analyte groups. Some loss of metals and radionuclides occurred in collection, transport, and equalization of the influent surface water. A significant loss of VOCs occurred in collection, transport, equalization, and mixing of the surface water in the reaction tanks of the RRS.

The cost of treatment (excluding residuals management) of surface water during Phase II was approximately $402/1,000 gallons treated, or $153 per gram of total metals removed, $14,100 per gram of total radionuclides removed, and $3,000 per gram of total VOCs removed. The high unit costs for analyte removal largely reflect the low influent analyte concentrations, and accordingly, the low analyte mass removal rates.

Residual waste generation includes not only sludge and spent GAC, but also air emissions from the diesel generator, solid waste in the form of used air and oil filters from the generator, and contaminated PPE used in sampling and maintenance activities. The amount of sludge produced per unit mass of analyte removed averages as follows: approximately 1.9 pounds of sludge/gram metals, 173 pounds sludge/gram radionuclides, and 8.5 pounds of spent GAC/gram VOCs. The costs associated with treatment and disposal of these wastes have not yet been assessed but are estimated at $124,000 for sludge and $6,000 for spent GAC for the Phase II reporting period inventory. These wastes are currently being stored in RFP interim storage areas, pending final treatment and/or disposal.

7.1.2 Surface Water Quality

The surface water characterization indicates that while the seep at SW-59 contains analytes in concentrations that exceed ARARs with significant frequency and magnitude, the surface water quality at SW-61 and SW-132 exhibits limited ARAR exceedances. Analyte concentrations in untreated surface water at SW-61 and SW-132 typically are below or near ARARs, which are the effluent standards for the treatment facility.

7.2 RECOMMENDATIONS

7.2.1 FTU Operation

During the course of preparing this report, recommendations have been developed to reduce operational costs of the FTU, in particular, in the area of waste generation and management. These recommendations have already been implemented. Of greatest significance is the change in GAC changeout operations. GAC changeout had previously been performed at preset intervals (120 days) without regard for utilizing the full capacity of the GAC units. This approach to operation and maintenance was considered necessary due to constraints imposed by the use of off-site analytical laboratory services. Because off-site analytical services could not provide rapid turnaround analysis for GAC breakthrough, GAC units were changed based on calculated expected breakthrough times. Currently, GAC units are changed when it is determined that breakthrough has occurred in accordance with a GAC monitoring plan that involves the use of on-site analytical laboratories that provide rapid turnaround analysis. These measures have extended the in-service period for the GAC units thus reducing the quantity of spent GAC in storage.

7.2.2 Future Surface Water Management

Contrary to information provided in the IRAP (DOE, 1991), the collection and treatment system has been processing surface water that exhibits relatively low levels of VOCs and radionuclides. In particular, surface water collected from SW-61 and SW-132 has low VOC/radionuclide levels, but contributes the majority of the total flow to the treatment system. These two flows serve to dilute the higher VOC/radionuclide levels in the seep water at SW-59. As a result, the overall reduction in VOC and radionuclide concentrations due to treatment is small for the VOCs and imperceptible for the radionuclides.

Considering the low frequency and magnitude of ARAR exceedances at SW-61 and SW-132, the collection and treatment of these sources is not necessary to achieve the OU2 IM/IRA objectives. Given the low frequency and magnitude of ARAR exceedances, and in light of the high cost of treatment including the cost of secondary waste management, it is recommended that collection and treatment of SW-61 and SW-132 be discontinued. It is recommended that collection and treatment of surface water at SW-59 be continued because VOCs frequently and significantly exceed ARAR. If collection of surface water at SW-61 and SW-132 is discontinued, this will make available approximately 98% of the treatment system capacity for treatment of contaminated groundwater or other surface water from OU2 or from other OUs. For example, the system is currently intended for use in treating groundwater generated from the OU2 Subsurface IM/IRA.

Because analyte concentrations occasionally exceed ARARs at stations at SW-61 and SW-132, particularly VOCs at SW-61, it is recommended that the current monitoring program be maintained to observe the trend in analyte concentrations at these sources. If the trend is toward more frequent and higher ARAR exceedances, discontinued collection and treatment of SW-61 and/or SW-132 will be reevaluated, and additional source characterization may be recommended based on the magnitude of observed changes. Results of the monitoring at these stations will be reported in the quarterly reports prepared for the FTU.

Section 8

SECTION 8

REFERENCES

DOE 1991: Final Surface Water Interim Measures/Interim Remedial Action Plan/Environmental Decision Document - South Walnut Creek Basin (OU-2), U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, March 8, 1991.

DOE 1992: Summary and Analysis of Results, Field Treatability Study, Granular Activated Carbon Treatment System, Phase I, South Walnut Creek Basin, Surface Water Interim Measure/Interim Remedial Action, Operable Unit No. 2, Rocky Flats Plant, Golden, Colorado, May 1992.

EG&G 1991a: Rocky Flats Plant Site-Wide Quality Assurance Project Plan, Draft, 13 February 1991.

EG&G 1991b: Rocky Flats Plant Site-Wide Quality Assurance Project Plan, Quality Assurance Addendum 2.3, South Walnut Creek Surface Water Treatment Facility, Operable Unit No. 2, March 1991.

EG&G 1991c: Operations and Maintenance Manual, OU2 Treatment System, EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado, June 17, 1991.

EG&G 1991d: General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Version 2.1, EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado, August 20, 1991.

EG&G 1991e: Final Field Treatability Study, Field Sampling Plan, Phase I, South Walnut Creek Basin, Surface Water Interim Measures/Interim Remedial Action, EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado, August 22, 1991.

EG&G 1991f: Phase I Work Plan, South Walnut Creek Basin, Manual No. 21100-WP, OU 02.3, EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado, August 23, 1991.

EG&G 1991g: Project Management Manual No. 21100-PM, Operable Unit No.2, South Walnut Creek, EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado, October 28, 1991.

EG&G 1992a: Water Quality Parameters Data Evaluation Guidelines. EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado, January 1992.

EG&G 1992b: Waste Requirements Procedures Manual No. 5-23000-WRP, Procedure WO1101, Radioactive Waste Packaging Outside the PA, EG&G Rocky Flats Plant, Golden, Colorado, July 10, 1992.

EG&G 1992c: Waste Requirements Procedures Manual No. 5-23000-WRP, Procedure WO1102, Waste Residue Traveller, EG&G Rocky Flats Plant, Golden, Colorado, July 10, 1992.

EG&G 1992d: Waste Requirements Manual No. 1-10000-WRM, Procedure WO-4034, Radioactive Waste Packaging Requirements, EG&G Rocky Flats Plant, Golden, Colorado, August 12, 1992.

EG&G 1992e: Background Geochemical Characterization Report. EG&G Rocky Flats, Rocky Flats Plant, Golden, Colorado, September 1992.

EG&G 1993a: Environmental Application of the Particle Analysis System, Environmental Protection Management Department, Surface Water Division, EG&G Rocky Flats Plant, Golden, Colorado, February 26, 1993.

EG&G 1993b: Phase II Draft Work Plan, South Walnut Creek Basin, EG&G Rocky Flats/Environmental Management, Rocky Flats Plant, Golden, Colorado. 1993.

EG&G 1993c: Waste Stream and Residue Identification and Characterization, Building 900D, Version 3.2, EG&G Rocky Flats, Rocky Flats Plant, Golden, Colorado, March 25, 1993.

EG&G 1993d: Final Sampling and Analysis Plan for Operation and Maintenance of the Field Treatability Unit for Operable Unit No. 2, Rocky Flats Plant, Golden, Colorado, June 1993.

EPA 1980: Upgrading Environmental Radiation Data, Health Physics Society Committee Report HPSR-1 (1980), EPA 520/1-80-012, U.S. Environmental Protection Agency, August 1980.

EPA 1987: Data Quality Objectives Guidance for Remedial Activities: Development Process and Case Studies, EPA/540/G-87/003 and 004, OSWER Directive 9355.0-7B, March 1987.

EPA 1988a: Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis. U. S. Environmental Protection Agency, January 1, 1988.

EPA 1988b: Laboratory Data Validation Guidelines for Evaluating Organics Analysis. U.S. Environmental Protection Agency, January 1, 1988.

EPA 1990: Airs Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Pollutants (March 1990), EPA 450/4-90-003.

IAG 1990: Federal Facility Agreement and Consent Order. State of Colorado Docket #91-0122-01 (InterAgency Agreement).